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CHAPEL HILL, N. C., U. S. A.

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PLATE 1

LACTARIUS SUBPURPUREUS

No. 1246. Natural Size

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Volume XXXIV JUNE, 1918 Nos. 1 and 2

THE LACTARIAS OF NORTH CAROLINA

By W. C. Coker

Plants fleshy, the cells of the cap flesh in great part vesicular as in Russula, when broken exuding a milky juice (latex) which is white or colored (occasionally almost watery) and mild or acrid; gills adnate or decurrent; stem central, its flesh continuous with that of the cap; spores globose to short-elliptic, warted or with combined warts and ridges, very rarely smooth. In a few species the milk may be mild at one time and acrid at another.

This genus is distinguished from Russula mainly by the milky juice, but there are certain more intimate distinguishing characters that are usually present and that one soon learns to recognize, *e. g.,* the cap in this genus is often zoned and the texture is usually less fragile than in Russula. The abundance of the milk varies greatly in different species, and in some, especially after maturity, it may disappear at times. Berkeley and Ravenel describe a species of Lactarius without milk that they name *L. illachrymans,* and it is reported from North Carolina by Curtis, but I have found so many species of Lactarius without milk when dry or old that I agree with Miss Burlingham in not considering this a good species without further evidence.

In practically all texts the spores of Lactarius are described as white, but this is not correct for many species. They vary with the species from pure white through cream, buff, yellowish, to ochraceous or light cinnamon and have sometimes a tint of pink or salmon.

All species with pleasant taste when fresh are supposed to be edible, and many of the peppery ones that have been considered poisonous have now been found to be harmless. The peppery taste disappears

in cooking. Only a few species are still thought to be harmful (such as *L. rufus, L. torminosus, L. fuliginosus, L. pyrogalus,* and *L. scrobiculatus*), but none should be eaten without caution unless certainly known to be good.

To Miss Gertrude Burlingham, who has carefully studied the Lactarias of America, I am greatly indebted for help in determining a considerable number of my most puzzling collections. For the errors, of course, I alone am responsible. All collections are from Chapel Hill unless some other locality is given. Asheville records were obtained from Mr. Beardslee by correspondence. The photographs were all made by me except that of *L. subdulcis,* which was taken by Mr. J. N. Couch. All are natural size unless otherwise noted. The spores were drawn by me and inked in by Mr. Curtis Vogler, our assistant in botany. The colored plate was painted by my niece, Miss Gladys Coker.

Important American literature:

Burlingham. A Study of the Lactariæ of the United States. Memoirs Torr. Bot. Club **14**:No. 1. 1908.

Burlingham. Lactariæ. N. Am. Flora **9**:172. 1910.

Peck. N. Y. State Cab. Rep. **23**:114. 1872. Bot. Ed.

Peck. N. Y. State Museum Rep. **38**:111. 1885.

KEY TO THE SPECIES*

A. Milk bright colored from the first................1
- 1. Milk salmon ....*L. Curtisii* (33)
- 1. Milk blue ....*L. Indigo* (28)
- 1. Milk dark red ....*L. subpurpureus* (27)
- 1. Milk orange or reddish-orange................*L. deliciosus* (25)
- 1. Milk saffron-yellow ....*L. Chelidonium* (26)

B. Milk white at first, then turning yellow..........
- 1. Margin of young cap strongly felted-tomentose..*L. scrobiculatus* (13)
- 1. Margin of young cap smooth or minutely tomentose 2
- 1. Entire cap and stem tomentose, white.........*L. vellereus* (3)

---

*Figures in parenthesis refer to the species number.

Two species of Lactarius have been found both north and south of us, but do not seem to have been recorded from North Carolina. They are *L. involutus* and *L. alpinus.* The former is distinguished by its small size (2-5 cm.), white or pale ochraceous color, very acrid milk, minutely silky margin and very small spores; the latter by its small size (1.5-4 cm.), tawny-ochraceous color, squamulose cap and white acrid milk. For full descriptions of these see Burlingham, Lactariæ of the U. S., Memoirs T. B. C. *14,* No. 1: 26 and 79. 1908; or North Am. Flora *9*: 177 and 191. 1910.

2. Milk bitterish, then moderately acrid, smell pungent .... *L. theiogalus* (29)
2. Milk decidedly acrid 3
3. Cap light yellow with spotted zones............ *L. chrysorheus* (30)
3. Cap deep yellow, zones faint and unspotted.... *L. croceus* (23)
3. Cap maize-yellow with salmon tint, zones faint.. *L. delicatus* (24)
C. Milk white at first, then turning lilac or heliotrope. *L. speciosus* (22)
D. Milk or flesh white at first, then turning salmon or reddish or pink 1
1. Cap smooth (minutely pruinose when young) .. 3
1. Cap velvety .... *L. ligniotus* (41)
1. Cap margin coarsely felted tomentose.......... 2
2. Milk acrid .... *L. torminosus* (9)
2. Milk mild .... *L. subtorminosus* (10)
3. Gills not very distant, stem becoming hollow... *L. plinthogalus* (39)
3. Gills very distant, stem solid.................. *L. subplinthogalus* (40)
E. Milk white, then turning slowly to a deep brown.. *L. luteolus* (46)
F. Milk or flesh white, then turning (sometimes quite slowly) to greenish or olive, or greenish-brown, or greenish-blue, or greenish-cream............ 1
1. Cap white, smooth, gills very much crowded... *L. pergamenus* (2)
1. Cap white (at times with faint lilac or cream tints), velvety, tomentose, gills moderately crowded, flesh turning light greenish-cream.. *L. subvellereus* *Form A* (4a)
1. Cap minutely velvety, reddish or pinkish-cinnamon or in part whitish, gills not crowded.... *L. Allardii* (5)
1. Cap greenish .... *L. atroviridis* (8)
1. Cap an earthy-gray-brown color, milk becoming greenish .... *L. rusticanus* (7)
1. Cap yellowish-ochraceous, gills many times forked .... *L. furcatus* (11)
1. Cap sepia in center, light on margin, milk drying blue-greenish gray .... *L. mucidus* (17)
G. Milk white, or watery white, or light cream color, unchanging 1
1. Milk bitterish, slightly or not at all acrid...... 2
1. Milk quite mild, not bitterish or acrid......... 4
1. Milk barely acrid, not bitterish................ 3
1. Milk moderately or decidedly acrid (also bitterish in some cases)........................ 12
2. Cap and stem tomentose..................... *L. lanuginosus* (20)
2. Cap and stem smooth (base of stem may be fibrous), margin not striate or faintly so..... *L. subdulcis* (50)
3. Surface velvety .... *L. Gerardii* (42)
3. Surface glabrous .... *L. subdulcis* (50)

3. Surface squamulose, slate gray to smoke gray . . *L. griseus* (38)
3. Surface squamulose, grayish vinaceous . . . . *L. griseus. Form A* (38a)
3. Surface squamulose, reddish or yellowish brown . *L. helvus* (36)
4. Texture extremely tough, margin strongly cracked, gills thick, very distant . . . . *L. lentus* (47)
4. Cap squamulose-warted or floccose-squamulose . . 5
4. Cap cracked all over into minute areas . . . . *L. rimosellus* (49)
4. Cap not squamulose or cracked 6
5. Cap slate gray to smoke gray . . . . *L. griseus* (38)
5. Cap grayish vinaceous . . . . *L. griseus. Form A* (38a)
5. Cap reddish or yellowish brown . . . . *L. helvus* (36)
6. Surface pruinose, gills distant . . . . *L. hygrophoroides* (44)
6. Surface velvety 7
6. Surface not velvety 8
7. Gills distant . . . . *L. Gerardii* (42)
7. Gills not distant . . . . *L. corrugis* (45)
8. Cap sparingly coarse tomentose . . . . *L. lanuginosus* (20)
8. Cap glabrous 9
9. Odor aromatic, surface not cracked . . . . *L. camphoratus* (48)
9. Odor not aromatic 10
10. Milk very abundant, sticky, cap usually rugose . . *L. volemus* (43)
10. Milk not so abundant 11
11. Cap sordid brown . . . . *L. cyathulus* (32)
11. Cap ochraceous-buff or tawny, tall slender plant . *L. sp.?* (page 59)
11. Cap pinkish tan to wood brown . . . . *L. subdulcis* (50)
11. Cap light buff; low, broad plant . . . . *L. quietus* (31)
12. Cap white or creamy (brownish-cream in a form of *L. chrysorheus*) 13
12. Cap not white 18
13. Surface glabrous, even on margin 14
13. Surface not glabrous 15
14. Not zonate, flesh thin, gills very crowded, only 1 mm. wide . . . . *L. pergamenus* (2)
14. Not zonate, flesh thick, gills 2-3 mm. wide . . . . . . *L. piperatus* (1)
14. Zonate, brownish-gray . . . . *L. circellata* (18)
14. Zonate, brownish-cream . . . . *L. chrysorheus. Form A* (30a)
15. Surface velvety tomentose 16
15. Surface slightly tomentose, brownish-gray, zonate . . . . *L. circellatus* (18)
15. Surface glabrous except on margin . . . . *L. deceptivus* (6)
16. Gills distant . . . . *L. vellereus* (3)

16. Gills close 17
17. Stem bluish gray at top........................*L. subvellereus*. *Form A* (4a)
17. Stem not bluish gray at top....................*L. subvellereus* (4)
18. Margin persistently felted-tomentose until maturity ....*L. torminosus* (9)
18. Margin not tomentose at maturity.............19
19. Stem distinctly spotted, gills little forked......*L. insulsus* (14)
19. Stem distinctly spotted, gills repeatedly forked.*L. furcatus* (11)
19. Stem not distinctly spotted....................20
20. Cap velvety, dry 21
20. Cap squamulose, dry, color russet-vinaceous....*L. griseus*. *Form A* (38a)
20. Cap not velvety, viscid, at least when wet......22
20. Cap not velvety, dry or faintly viscid..........*L. subdulcis* (50)
21. Cap deep red-brown ....*L. Peckii* (37)
21. Cap slate or smoky-gray.......................*L. griseus* (38)
22. Stem very short, cap fibrous, quite viscid.......*L. cilicioides* (12)
22. Stem not very short...........................23
23. Cap very viscid, slimy........................24
23. Cap moderately viscid when wet...............25
24. Cap reddish orange ....*L. coleopteris* (16)
24. Cap buff, surface rugose......................*L. agglutinatus* (19)
24. Cap yellow-brown with olive tint..............*L. turpis* (21)
24. Cap smoky-gray with tint of violet.............*L. cinereus* (35)
25. Cap orange to buff or straw color, usually zoned.*L. insulsus* (14)
25. Cap not zoned, grayish-lead with liver tint.....*L. trivialis* (15)
25. Cap not zoned, fulvous in center, cinnamon towards the *crenate* margin..................*L. minusculus* (34)

1. **Lactarius piperatus** (L.) Pers.

PLATE 2.

Cap about 6-12 cm. wide, depressed in center and margin upturned; surface quite smooth and somewhat shining, nearly milk white, or with dull dirty white or buff shades. Flesh white, rather soft, not changing color on exposure. Milk copious, white and unchanging, exceedingly peppery.

Gills only fairly close, many forked, from 2-3 mm. deep; creamy at first, then darkening a little, becoming light buffy brown where bruised.

Stem usually short and tapering downward, about 3 cm. or sometimes up to 5 cm. long, varying much in thickness, 1.3-2.5 cm. in diameter, quite smooth or slightly pruinose, white, or with buff shades and stains, solid, but with soft flesh like the cap.

Spores (of No. 585) varying greatly in size in the same spore-print, pure white, short-elliptic, very minutely warted to almost smooth, 6.7-7.5 x 8-13, averaging about 7.4 x 11μ.

A large white species that is common in dry woods in fall and not rare in summer. It is distinguished from *L. deceptivus* by smooth stem and more crowded and narrower gills; and from *L. glaucescens* by the much less close and somewhat deeper gills, the milk not turning greenish and cap more shining. The plants also run considerably larger than *L. glaucescens,* and the flesh is somewhat firmer, and the milk more peppery than in that species. Distinguished from *L. vellereus* by smooth cap and stem and closer gills.

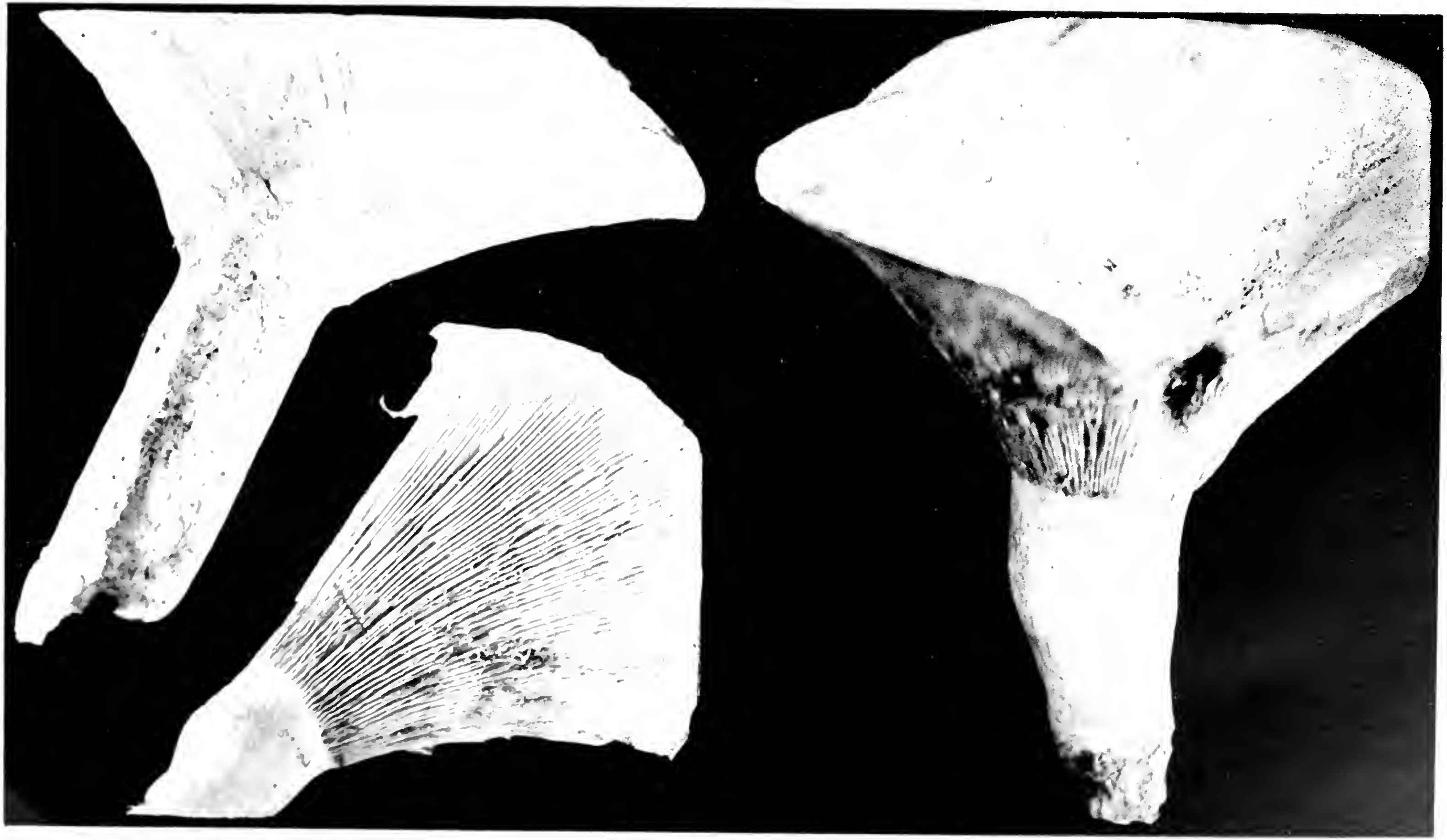
In the mountains of this State (Pisgah Forest) Miss Burlingham found a fragrant form of this species of which she writes as follows:

"In North Carolina I found plants agreeing in all other essentials with *Lactaria piperata* except that the latex dried a pale yellowish, and the fresh plant when wet or when rubbed had the odor of crushed blackberries, and the gills were slightly less crowded. This can scarcely represent more than a form of the species, and on account of the odor, which is the distinguishing characteristic, I will refer to it as form *fragrans.* It is No. 79, 1907, of my North Carolina plants. Gillet recognizes a form *amara,* in which the milk becomes yellowish in drying, but the plant is odorless."

586. Low place below branch below Howell's spring. October 17, 1912.
906. Woods near cemetery, October 10, 1913. Spores 6.3-7.5 x7-8.5μ, very minutely warted.
1052. Woods south of South Building, September 16, 1910.
1211. On side of well shaded hill near path along right-hand side of Bowlin's Creek, a short distance below Fern Banks, July 25, 1914. Photo.

Common, in dry woods. Curtis.
Blowing Rock. Atkinson.
North Carolina (mountains). Burlingham.
Asheville. Beardslee.

PLATE 2



LACTARIUS PIPERATUS. No. 1211

2. **Lactarius pergamenus** Fr.
L. glaucescens Crossland.

PLATES 3 AND 40.

Cap 7-13 cm. broad, depressed in center at maturity, the margin upturned, surface dry, not zoned, smooth or more often rugose-wrinkled as in *L. volemus,* especially towards the center, glabrous, nearly white or with brownish-buff shades and deeper colored areas, especially when old; rarely with a faint pinkish tint. Flesh nearly white or creamy, firm and solid. Milk white at first, changing slowly to a glaucous green or not changing, very peppery or at times only moderately so.

Gills very close, narrow, many forked, only 1.5 mm. wide, white at first, then light fleshly cream, turning honey color in fresh plants when wounded, or a glaucous green usually where there is much milk, and in age becoming dull cinnamon-straw color.

Stem 4-5 cm. long, smooth, pruinose when very fresh, color of cap, 1.3-1.7 cm. in diameter in middle, tapering very gradually downward, very firm and solid.

Spores (of No. 904) pure white, spherical to short-elliptic, smooth, 5-5.6 x 6-7.5μ.

This species is most like *L. piperatus,* but differs in the much closer and even narrower gills, more solid and firm flesh, much less peppery milk, and smaller and smoother spores. The green color of the milk cannot be relied upon, as in the same plant it may change color in one part and not in another.

Miss Burlingham has recognized the name *L. glaucescens* as covering the form with greenish change, but our plants agree so exactly with Fries' description that I do not think we are justified in considering this whimsical character as of specific importance.

Very abundant in summer. In mid-July, 1917, it was more abundant, perhaps, than all other mushrooms put together, and it is, therefore, important to know that the species is not only edible but very good when properly prepared. If the plants are parboiled and the water thrown away the peppery taste is got rid of, and they may then be creamed or otherwise served to taste.

904. Woods near cemetery, October 10, 1913. Photo.
1195. Scattered through low woods south of cemetery, July 23, 1914. A fine lot of plants in all stages, giving good evidence of the species character. Many were decidedly rugose, mostly in central part, quite as much so as *L. volemus* often is; milk plentiful and moderately peppery, white at first, sometimes turning a fine olive green and sometimes not turning green. Many cuts were made to test this, and in most of the plants some of the milk would turn green and some would not, just as in collection No. 904. Spores pure white, spherical to short-oval, smooth or minutely roughened, one large oil drop, 3.4-5.1 x 5.1-6.8μ.
1184. In woods east of Graded School, July 22, 1914.
1550. Mixed pine and oak woods by path to Meeting of the Waters, June 18, 1915. Spores elliptic, slightly roughened, 4.5-5.4 x 6.3-7.5μ.
1583. In dry sandy soil in woods north of Judge Brockwell's, June 21, 1915.
1672. Woods near Meeting of the Waters, July 26, 1915. The largest of these typical plants was 13 cm. wide. In one of the young plants the gills were of a decided green tint all over when untouched.

Low districts, in woods. Curtis.
Blowing Rock. Atkinson.
Asheville. Beardslee.
Pink Bed Valley (as *L. glaucescens*). Burlingham.

3. **Lactarius vellereus** Fr.

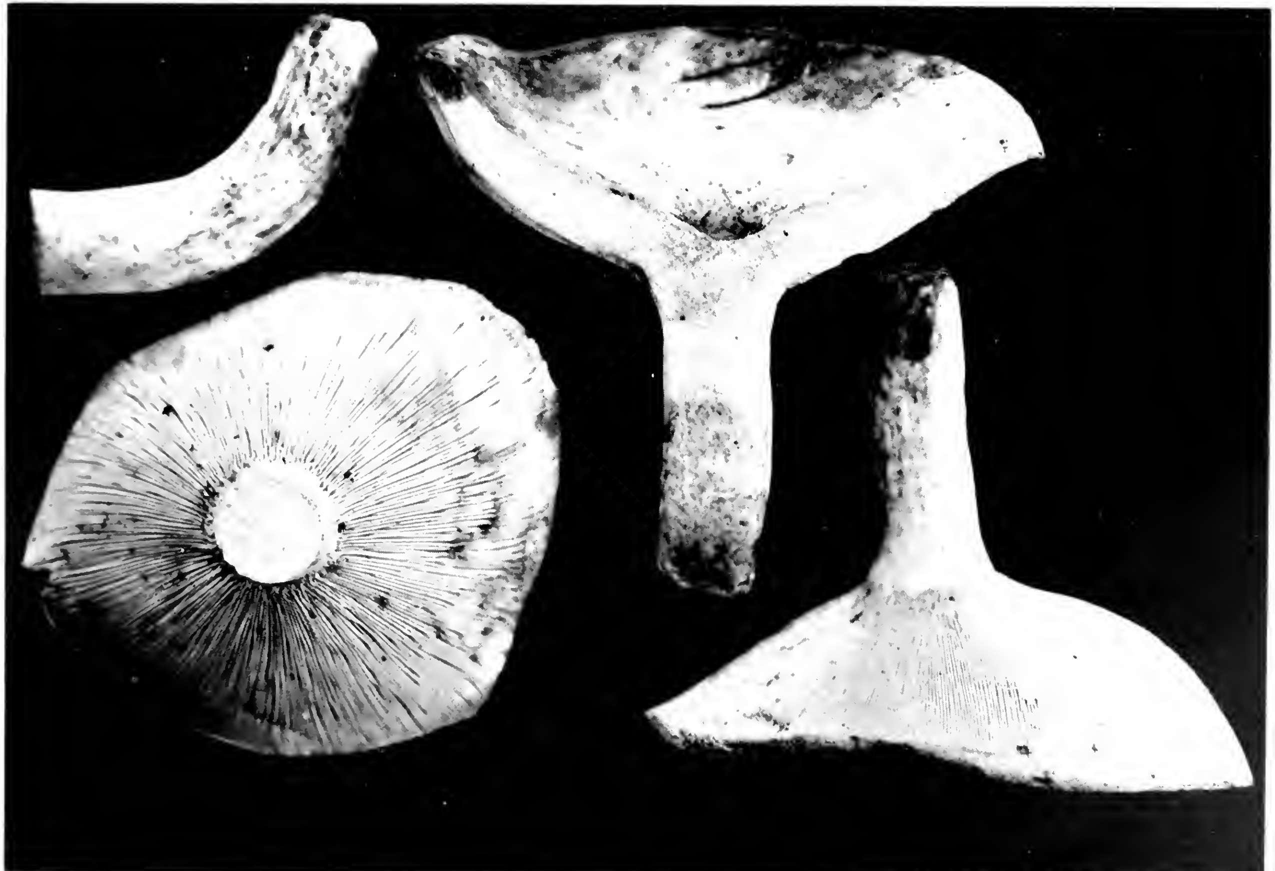
PLATES 4 AND 40.

Cap deeply infundibuliform, often containing water like a cup, and frequently split down one side; when young strongly involute on the margin. Surface dry, whitish or buffy, closely and finely tomentose, or varying to more roughly tomentose, smooth. Flesh about 8-10 mm. thick near stem, moderately soft, white, but turning a dull brownish yellow or cream color when cut. Milk white and remaining so or changing to a decided creamy yellow, very peppery.

Gills usually somewhat distant when young, becoming distinctly distant at maturity, narrow, not regularly forking, but the short marginal ones often anastomose with the long ones; color nearly white when young, turning maize yellow at maturity, with faint tint of flesh color when seen at an angle.

Stem short, stout, tapering downward, 3-4 cm. long and about 1.5-2.5 cm. thick, solid but soft inside and often cavernous by grubs;

PLATE 3



LACTARIUS PERGAMENUS. No. 904

surface white, minutely soft-tomentose, the white tomentum often missing in areas, sometimes over a large part of the stem (such places are smooth and show the brownish tan sub-layer).

Spores (of No. 1585) oval or slightly elliptical, very minutely tuberculate, or some seem smooth, 6.6-7.5 x 7.5-9.5μ. Cystidia cylindrical, often with a point or knob.

A large species, usually white all over except for yellowish discolorations in age. Dried plants are a rich buff or buffy cinnamon, the stem often darkest; the gills reddish brown and glaucous. It may be distinguished from all others near it, except *L. subvellereus* and *L. Allardii* by its tomentose cap and stem. It is very common in woods in summer, more common at times even than *L. piperatus, L. pergamenus,* and *L. deceptivus.* The latter, which has a tomentose stem, is easily distinguished by the conspicuously rough spores and lighter color of all parts when dry. Miss Burlingham also mentions the occurrence at times of yellowish latex in this species as recorded by Earl and by Massee.

108. Mixed woods near Sparrow's Point. October 2, 1908.
109. Open woods east of campus, September 18, 1908.
110. Battle's Park, below Piney Prospect, October 13, 1908.
1199. In hollow south of cemetery and near path by branch west of cemetery, July 23, 1914. Photo. Milk white, but changing to a decided cream-yellow, very peppery.
1207. By path along Battle's Branch, just where east path to Piney Prospect leaves the branch, July 24, 1914. Spores spherical to short-elliptic, some apparently quite smooth, others with a few minute tubercles, 7-9 x 8-11μ.
1551. Woods south of athletic field, near branch, June 18, 1915. Spores subspherical to elliptic, smooth, clear, 5.4-6 x 7.2-9.4μ.
1585. In woods by path to Piney Prospect, June 21, 1915. Spores subspherical, nearly smooth, 6.6-7.5 x 7.5-8.5μ.
1632. Among leaves by branch north of Meeting of the Waters, July 23, 1915. Photo. Gills distant, about 4 mm. deep in middle, pale cream color, brownish-buff when wounded; milk peppery, turning cream and tan-buff; cap tomentose; stem minutely tomentose, in places only pruinose; flesh turning creamy when cut.

Blowing Rock. Atkinson.
Common, in dry woods. Curtis.
Asheville. Beardslee.

4. **Lactarius subvellereus** Pk.

Plants considered typical of this species except for somewhat more distant gills were collected in the mountains of this State by Miss Burlingham. She describes the species as follows (Mem. Torr. Bot. Club **14**:23. 1908):*

"Pileus fleshy, thin, convex, soon umbilicate, at length nearly infundibuliform, white, becoming tinged or spotted with yellowish, and when dried cinnamon colored (323.t.1-4), azonate, dry, covered with velvet-like tomentum, 7.5-15 cm. broad, margin at first and for some time very involute, at length spreading; gills white to pale cream-colored, staining amber-white (12.t.4) where the latex dries, often forking, adnate or slightly decurrent, narrow; stem white, tapering slightly toward the base, dry, velvety-pubescent, firm, 1.8-2.8 cm. long, 1.2-2.5 cm. thick; flesh amber-white, odor faint; spores subglobose, smooth, 6-6.5 x 6.5-7.5μ, latex pale cream-colored or whitish, very acrid, usually abundant.

"Hab.: On dry ground, mixed woods. July.

"DISTINGUISHING FIELD-MARKS: This species differs from *L. vellerea,* to which it is closely related, in the narrow close gills, and the finer velvety tomentum or pubescence covering the pileus and the stem. The latex is cream-colored or dries yellowish on the gills. The change in color of the pileus and stem during drying is a marked characteristic."

Mountains. Burlingham.

4a. **Lactarius subvellereus** Pk. Form A.

PLATES 5 AND 40.

Cap of moderate or large size, up to 15.5 cm. wide, strongly depressed in center, the margin plane or drooping, more graceful than *L. vellereus;* color white, sometimes with faint lilac or cream tints, very closely and finely tomentose all over. Flesh thin, only about

*I consider it very doubtful if *L. subvellereus* is a good species. The few characters supposed to separate it from *L. vellereus* are quite variable and confusing. Plants with close gills may have coarse tomentum and those with distant gills may have plush-like tomentum. The only two distinctions brought out by Peck are the closer gills and yellowish change in milk. The latter is often shown by typical *L. vellereus.*

PLATE 4

LACTARIUS VELLEREUS. No. 1632

PLATE 5

LACTARIUS SUBVELLEREUS. FORM A. No. 1218

7 mm. thick near the stem, firm, white, turning light greenish cream when cut, with a faint tint of bluish gray, peppery to the taste. Fresh milk was not obvious, as the plants were very dry, but it probably turns a greenish cream as indicated by cut flesh.

Gills quite close when young, moderately narrow, about 2-2.5 mm. deep in good-sized plants, light greenish cream in young plants, then dull cream, then cinnamon-buff (Ridgway). The gills fork only slightly, but often anastomose, particularly near the margin. In this collection (No. 1218) the gills in all the six plants were abundantly dotted on the edges with small milk-white droplets of dried milk.

Stem rather short, but not so stubby as in *L. vellereus,* 2-4.5 cm. long, 1.2-2 cm. thick, tapering downward; surface finely velvety like the cap, white except at the top where it is bluish gray. The flesh is like that of the cap and turns the same color when cut, very solid and not becoming cavernous.

Spores white, smooth, oval, 5.1-6.5 x 6.8-8.5μ.

One of the most notable characters of this collection was the bluish-gray color of the stem surface at the top and the faint tint of this same color in the gill surface and cut flesh.

The plants differ from typical *L. vellereus* in the closer and narrower gills which are not maize-yellow; more finely tomentose cap (the tomentum of *L. vellereus* is in places almost hairy under a lens); firmer stem; more graceful shape, and tints of green in cut flesh. It is like *L. subvellereus* except for the swamp habitat, the bluish-gray color of the stem apex and same tint plus greenish in the cut flesh. In these characters and in the greenish tint of flesh it approaches *L. Allardii,* but it differs from that in the white cap, gills not distinctly veined and not becoming reddish brown finally when wounded, in the less finely velvety cap and in the very different appearance of the dried plants which have lighter gills and darker, smoother stems than in *L. Allardii.* Miss Burlingham has seen my plants (No. 1218) and confirms their reference to *L. subvellereus.*

1218. In swamp of New Hope Creek, one-quarter mile below Durham road crossing, July 27, 1914. Two photos.

5. **Lactarius Allardii** n. sp.

PLATES 6, 7, AND 40.

Cap up to 17 cm. broad, azonate, deeply infundibuliform, the margin strongly inrolled until maturity, then nearly plane or uplifted, uneven, wavy, and often deeply lobed and distorted, surface quite dry, minutely velvety, not distinctly tomentose as in *L. vellereus,* color reddish cinnamon or pinkish-buff, often lighter towards the margin, sometimes with whitish areas where covered with leaves; when quite young the margin is white, then pinkish-buff or cinnamon. Flesh firm, thick, coarse, dry, rather brittle, about 1 cm. thick in middle, white, but slowly turning to pink with a faint lavender tint when cut. In young plants, where the milk appears on cutting, the pinkish tinge is followed after some minutes by an olive color; odorless until old age, then with a somewhat sweetish smell. Milk sticky, tardily but decidedly acrid, sparce, white at first then passing through the same colors as the cut gills.

Gills moderately close to rather distant when young, becoming subdistant to distant at maturity, from 1.5-3 mm. apart, nearly equal the whole length, about 2-4 mm. wide, attached to stem and only slightly decurrent, strongly veined at cap, more or less branched and sometimes anastomosing, many short ones, color when very young white, then a distinct cream, not dark with age, tinted here and there with pinkish-lavender; when wounded turning slowly to a distinct dull green, then to olive, and after a long time to deep reddish-brown or smoky-brown, and finally blackish-brown.

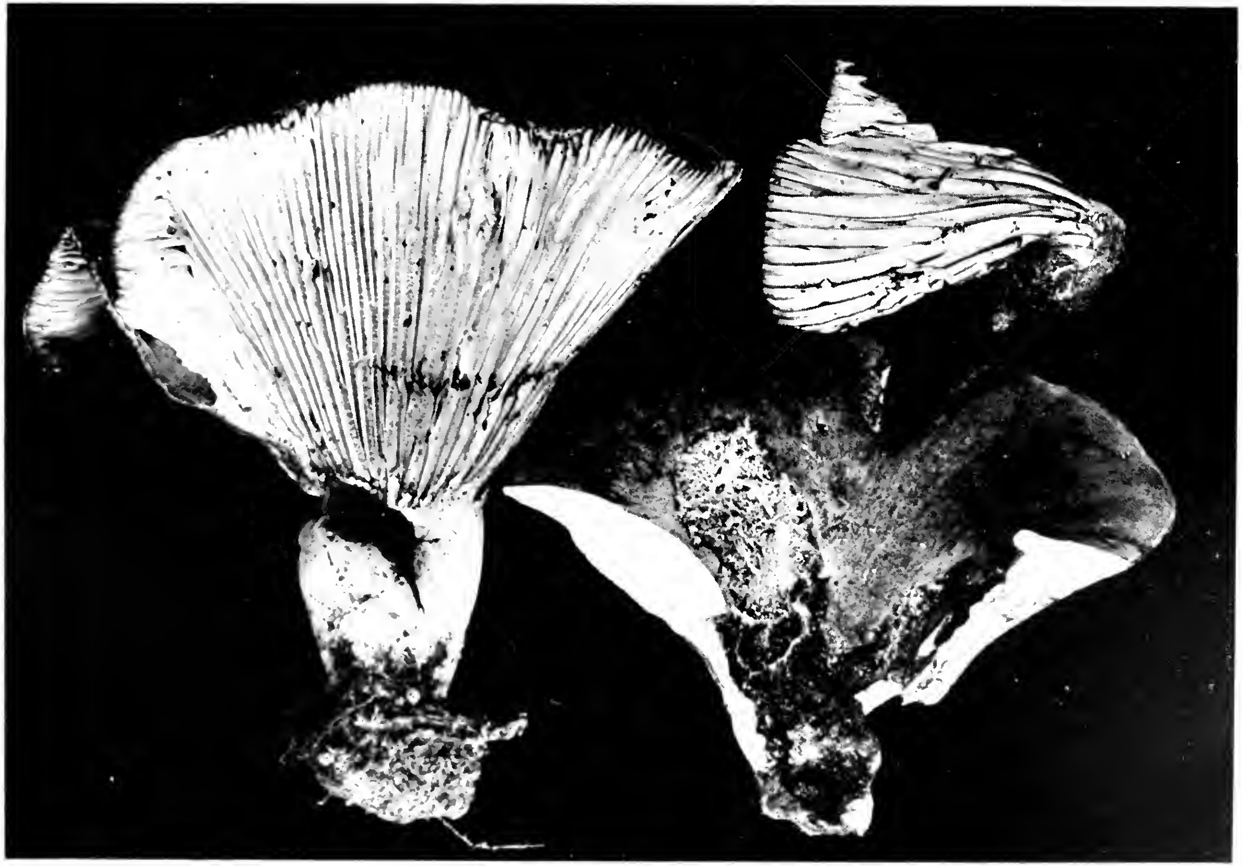
Stem short and thick, about 3-4 cm. long and 2.5-3 cm. thick, tapering downward, surface texture like that of cap, minutely velvety tomentose (scarcely more than pruinose); color pure white when quite young, then whitish or brownish below and pinkish-lavender or pinkish-buff above, or cinnamon-buff and white; texture firm and rather rigid, inside stuffed then cavernous in age.

Spores (of No. 1670) white, spherical to sub-elliptic, smooth or a few apparently minutely roughened, 6-9 x 7-10μ in diameter. Cystidia about 20-35μ long, mostly abruptly long pointed.

PLATE 6

LACTARIUS ALLARDII
No. 1154 (upper), reduced
No. 1670 (two lower), nat. size

PLATE 7



LACTARIUS ALLARDII. No. 1670. REDUCED

A large, brittle, deeply infundibuliform plant with velvety cap and stem, distant, cream-colored gills, and white, acrid milk, which slowly changes to olive and then deeper. It is most like *L. vellereus* and *L. subvellereus* Pk., but is easily distinguished by its decided color, milk turning olive green then red-brown on exposure, veined gills, lavender pink tint of stem surface and cut flesh. The dried plants of all the collections are distinctive in appearance and are unlike specimens of any form of *L. subvellereus* or of *L. vellereus*, particularly in regard to the stem, which is whitish and not rich buff or cinnamon and lacks the smooth velvety appearance of the others. The dried gills are a dark reddish-brown with a dull olive tint and are often very glaucous from the spores.

I take pleasure in naming this species for Mr. H. A. Allard, my first assistant in botany, who is now with the U. S. Department of Agriculture.

1154. In hollow southeast of athletic field, July 16, 1914. Two photos.

1176. Near branch, about 200 yards west of Meeting of the Waters, July 21, 1914. Milk becoming a distinct olive green; spores pure white, elliptic or subspherical, usually smooth, 5.5-7 x 7-10μ.

1178. In hollow southeast of athletic field, July 21, 1914.

1670. In mixed woods not far from Meeting of the Waters Branch, July 28, 1915. Photo. Type.

1726. Sandy soil in woods by branch north of Meeting of the Waters, September 10, 1915. Spores subspherical to short-elliptic, mostly quite smooth, a few minutely or doubtfully roughened, 6-8 x 7-9μ.

1874. In mossy, shaded, low place by branch, one-quarter miles below Meeting of the Waters, September 24, 1915. Photo. Three plants exactly like No. 1670, except that the gills were only sub-distant.

2329. Woods near branch above Meeting of the Waters, June 30, 1916. Ten fine plants; spores sub-globose, doubtfully roughened under highest power, 6-7 x 7-8.5μ.

2345. Damp woods by road to Scott's Hole, July 3, 1916.

2446. Deciduous woods north of Mr. M. F. Phillips', Yadkin College, North Carolina, about August 15, 1916.

2748. Low woods, Battle's Park, July 21, 1917.

6. **Lactarius deceptivus** Pk.

PLATES 8, 9, AND 40.

Cap usually about 10-11 cm. broad, deeply umbilicate, at first with the margin arched and strongly inrolled, later more expanded and

infundibuliform with the margin uplifted, still inrolled, outline rather regular, or lobed and unevenly developed on one side; surface quite glabrous except on the margin, which is typically covered with a soft, tomentose, cottony roll, appearance of white kid at first, with buff or brownish-ochraceous or cinnamon stains, then more or less cracking or roughish and more chalky looking. Flesh about 7 mm. thick at stem, pure white, elastic, not brittle, rather slowly but decidedly acrid, and with an unpleasant taste, thinning quickly on the inrolled portion; smell like sour bread, strong after maturity. Milk white, unchanging, acrid, sparce.

Gills rather crowded, in age less so, appearing slightly decurrent, 3.5-4.5 mm. wide in center, narrow at each end, white at first, then pallid cream, with an olive tint as they begin to dry, turning ochraceous or dull brown when bruised, some forked. Margin regular and even, remarkable for the fine fibers which often stretch across from gill to gill and are made visible by the spores that stick to them. They may be seen both in half-grown and mature plants.

Stem about 2-3 cm. long and 1.5-2.5 cm. thick at top, tapering downward and firmly attached at the blount base by fine mycelium; surface beautifully and densely soft white tomentose all over, quite firm and solid all through, the flesh like that of the cap, but at times with ochraceous stains.

Spores (of No. 1877) white, regularly elliptic, distinctly tuberculate, 7.4-8 x 10.6-11.2μ.

The plants grow among leaves and are often covered by them. The white mycelium is conspicuous running from the base of the stem.

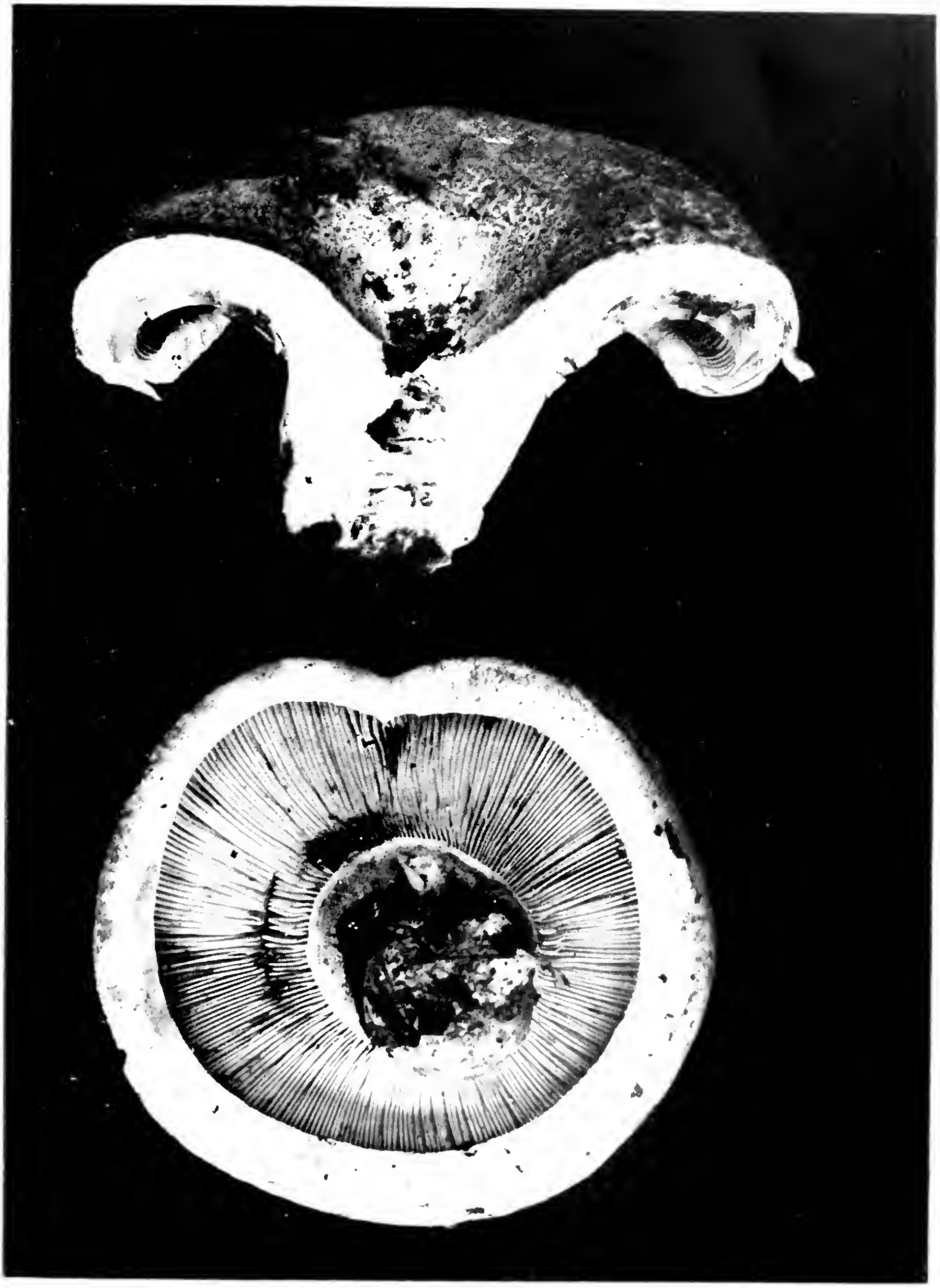
This species is much like *L. velereus,* but the cap is not tomentose as in that species except for the marginal roll, the spores are strongly warted, and dried plants are much lighter. It is also shaped like *L. piperatus,* but is easily distinguished from that species by the tomentose stem and much deeper and less crowded gills. For an illustration in color see N. Y. St. Mu. Rep. **54**: Pl. 70. 1902.

121. Chapel Hill, October 24, 1910.

558. Pine and oak woods near path south of campus, October 14, 1912.

883. In leaves, mixed woods south of cemetery, October 5, 1913. Photo. Spores tuberculate, 6.5-9.2 x 7.4-11μ.

PLATE 8



LACTARIUS DECEPTIVUS. No. 2749

PLATE 9

LACTARIUS DECEPTIVUS. No. 883

1877. Sandy soil in path by branch north of Meeting of the Waters, September 27, 1915. This is *L. deceptivus*, but is distinguished from the usual form by the entire absence of tomentum on the margin at all ages, by the closer and narrower gills. The smooth margin is probably due to the very dry weather.

2831. Low, damp deciduous woods at foot of Lone Pine Hill, September 14, 1917. Photo. Nearly white, but soon with buffy stains, old wounds changing to buffy-cinnamon. Spores strongly warted, 6.6-7.8 x 9-11μ.

Blowing Rock. Atkinson.
N. C. mountains, 1,000 to 1,675 meters elevation. Burlingham.
Asheville. Beardslee.

7. **Lactarius rusticanus** (Scop.) Burl.

L. pyrogalus Fr.

PLATES 10, 11, AND 40.

Cap 10 cm. broad, nearly flat, the center depressed. Surface smooth except for a scurfy appearance from the collapse in places of the lighter superficial layer; color a peculiar earthy gray-brown (near light drab—Ridgway) with zones of deeper soaked brown. Flesh white, thick, firm, unchanging. Milk white, moderately acrid, changing slowly to a light greenish-brown.

Gills light creamy-white, becoming fleshly-cream and sordid when bruised, ochraceous-buff at maturity, moderately close, about 4 mm. deep in center, scarcely pruinose.

Stem very smooth, even, brownish silvery-gray to ochraceous-buff, solid, 3-4.5 cm. long, 1-1.5 cm. thick.

Spores (of No. 1166) cream color, spherical, tuberculate, one oil drop, 6.5-7.4μ.

Miss Burlingham gives the range of this species as south only to Maryland.

1166. In sand in bottom of dry-weather branch, below sphagnum moss bed, July 20, 1914. Photo.

1615. Damp sandy soil just below Emerson's Pond, July 16, 1915. Photo.

Blowing Rock. Atkinson.

8. **Lactarius atroviridis** Pk.

PLATES 12 AND 40.

A firm heavy plant up to 10 cm. in diameter, with very short stem. Cap covered with a deep green tomentose-fibrous superficial layer which is distributed in different degrees in expanding: where it is thinnest the color is less intense. Flesh about cartilage color, scarcely changing when cut. Milk white, changing after a good while to a light dull green, very peppery.

Gills reaching stem, and in some cases slightly decurrent, only 3.5-5 mm. deep, not crowded, many short, but no forked ones, pallid flesh color changing to dull green then dirty earth color when bruised.

Stem short, 2.5-4.6 cm. long, 1.5-2.2 cm. broad at top, tapering downward, very fragile, stuffed, but hollowed by grubs. Its surface is like that of the cap, and it is also blotched in the same way with deeper and lighter green.

Spores light cream, spherical, distinctly tuberculate, 6.5-7.4μ in diameter.

Not before reported south of the District of Columbia. For an illustration in color see Mycologia **8**: Pl. 187. 1916.

790. Woods in Battle's Park, September 19, 1913.
872. About twenty feet from the brook in Battle's Park, behind Dr. Wheeler's house, October 3, 1913. Photo. Spores as above, 5.5-8.3μ.
903. Woods, Battle's Park, September, 1913.
1721. Growing in woods near branch west of Meeting of the Waters, September 9, 1915.
2300. Mixed woods south of Dr. Pratt's, June 28, 1916.

9. **Lactarius torminosus** (Schaeff.) Pers.

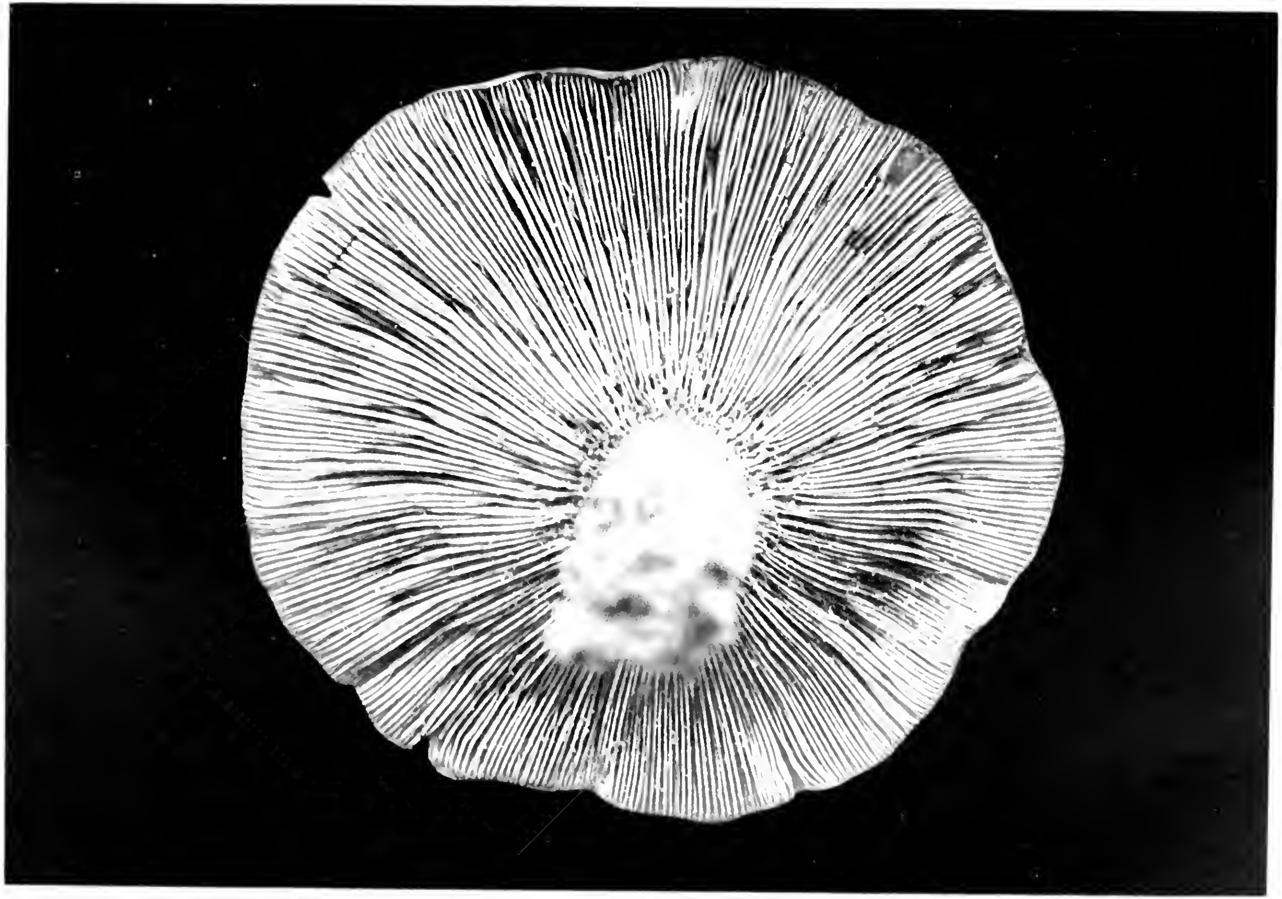
PLATES 13 AND 40.

Cap large, usually 10-12.5 cm. broad, strongly depresced in center to nearly infundibuliform, the margin involute until full maturity, surface zonate, dull-ochraceous or lighter creamy-tan with tints of pink or lavender pink at times, and in our plants always more or less distinctly zonate, viscid, felted tomentose on the marginal third until maturity, the margin most felted and remaining visibly so until full maturity or old age. Flesh only 6-7 mm. thick at stem, white, un-

PLATE 10

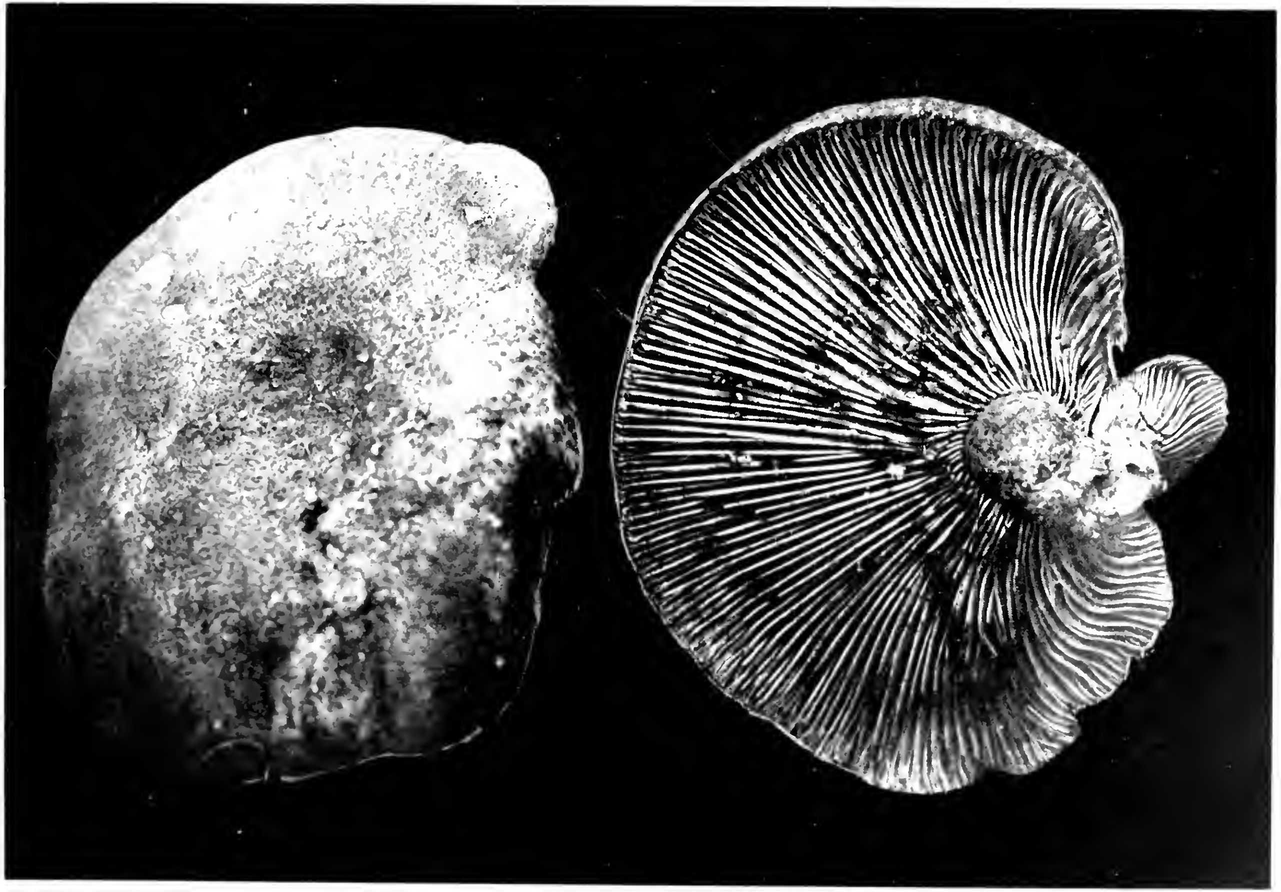
LACTARIUS RUSTICANUS. Nos 1166 (right) and 1615 (left)

PLATE 11



LACTARIUS RUSTICANUS. No. 1166

PLATE 12



LACTARIUS ATROVIRIDIS. No. 872

changing or (in a Chapel Hill form) turning when cut (if not too old) to light pink with or without a light tint of lavender; odor very slight, pleasant. Milk abundant, light creamy white, not changing, very acrid, but not otherwise disagreeable.

Gills crowded, narrow, only 3-4 mm. wide, nearly equal, the whole wavy, attached, some forking at the stem, nearly white, then creamy, then maize yellow with a distinct flesh tint, turning sordid brown when bruised.

Stem short, stout, 2.5-3 cm. long, and 1.6-2.2 cm. thick, usually equal, minutely pruinose-felted or somewhat smoothish, nearly white with more or less distinct yellowish scrobiculate spots, and sometimes with lavender-pink tints, firm and brittle, becoming hollow, the flesh at times becoming pink when cut.

Spores yellowish, elliptic, strongly tuberculate, 5.5-7.4 x 7.4-9.2μ.

Easily recognized by the large size, felted margin, and unchanging acrid milk. Distinguished from *L. cilicioides* by zoned cap with center smooth and less bright color of the gills when dry. It is poisonous, but the poison is said to disappear on cooking (Ford. Jour. Phar. and Exp. Ther. **2**:296. 1911). The species is described as having unchanging flesh, and this was true of our No. 764. In Nos. 2361 and 2393, on the other hand, the flesh turned pinkish when cut, though in other respects the plants were just like the typical form. The colored figure, given in Mycologia **8**: Pl. 87. 1916, would give a very misleading idea of our plant. Dried plants of this species at the New York Botanical Gardens appear exactly like ours.

764. Woods near Battle's Brook, Chapel Hill, September 14, 1913. Milk white, unchanging, decidedly acrid; pock-marks on stem, small and faint; no forked gills; flesh and gills not turning lilac or pink when cut or bruished; spores warted and ridged, 6.6-7.5 x 7.5-8.5μ. This is typical *L. torminosus*.

2361. Under cedars behind President's house, July 5, 1916. Photo.

2393. Under cedars behind President's house, July 18, 1916. In this and in No. 2361, representing numerous plants, the flesh turned light pink when cut.

Blowing Rock. Atkinson.
Asheville. Beardslee.
Pisgah Forest. Burlingham.

10. **Lactarius subtorminosus** n. sp.

PLATE 40.

Cap 5-6 cm. broad, irregular, coarsely tomentose, whitish with creamy or honey-colored zones, margin involute.

Gills crowded, 2-3 mm. broad, a few forked, cream at maturity, turning pink then light smoky-brown when cut.

Stem 1.5 cm. long, tapering downward, 1.1-1.5 cm. thick above, white with a few creamy dots, densely but minutely tomentose *all over,* or with a few scrobiculate spots, hollow.

Milk white, very sparce, quite mild. Taste of flesh like cypress wood.

Spores moderately warted and ridged, subspherical, 5.8-6.5 x 6.5-7μ.

This differs from *L. torminosus* (our pink-changing form) in the quite mild milk and much smaller spores. It differs from *L. speciosus* in change to *pink* and *smoky, not heliotrope,* and in the much smaller spores.

2813. In weeds and shrubs by sidewalk near Mrs. Gore's house, July 3, 1917. Type.

11. **Lactarius furcatus** n. sp.

PLATES 14 AND 40.

Cap 6-10 cm. broad, infundibuliform at maturity with the margin plane and narrowly revolute; surface with low, felted tomentum all over and remaining so, moderately viscid when wet, yellowish ochraceous, faintly many-zoned; margin not striate. Flesh white with distinct zones of dull ochraceous, up to 7 mm. thick near stem; no decided odor. Milk not abundant, white, then after many minutes a distinct glaucous green and remaining this color indefinitely; moderately acrid.

Gills quite crowded, very narrow, only 1.5-1.8 mm. wide, all *forking three or four times,* color fleshy-ochraceous with a tint of salmon.

Stem 2-3 cm. long and about 1.3 cm. thick, firm, solid, and tough, surface light yellowish with small ochraceous spots.

PLATE 13

LACTARIUS TORMINOSUS. No. 2361

PLATE 14

LACTARIUS FURCATUS No. 2232 TYPE

Spores fleshy-ochraceous, short-elliptic, faintly tuberculate, pointed and somewhat bent at one end, 3.5-4 x 3.7-6.6μ.

This large and very distinct species is decidedly marked by its crowded, much-forked gills, tomentose cap, and acrid milk which becomes green. It seems to be related most closely to *L. torminosus*, from which it is easily separated by its forked gills, green milk, and its nearly smooth and much smaller spores.

2232. Bank of New Hope Creek, near Durham bridge, June 24, 1916. Photo. Type.

12. **Lactarius cilicioides** Fr.

PLATE 15.

Cap 4-9 cm. broad, usually about 6-7 cm., sharply depressed in center, usually irregular and lobed; the margin extending beyond the gills and strongly inrolled when young, becoming plane only at full maturity or remaining sharply bent down; surface quite viscid, and often cracked and roughened, azonate, covered with viscid fibers which are usually stuck together and collapsed on the surface. In some cases a superficial, thin, viscid, shiny pellicle seems to cover the fibers. On the incurved margin the tomentum appears as a dense roll of coarsely woven and partly fused fibers which collapse at maturity. Color rather uniform, being a rather light "orange buff" or "pale yellow-orange," the central depression sometimes water soaked and deeper in color. Flesh about 8 mm. thick near stem, light and fleshy cream color, very spongy and dry like sponge cake; taste decidedly peppery; milk often entirely absent, even in young plants; when present very scant, white and remaining so, quite acrid.

Gills rather crowded, very little branched, about 4-6 mm. deep in middle, narrowing toward the stem and reaching it with a slight depression, lightly decurrent by lines in most cases; color a light cream with a pinkish tint at first, becoming a light creamy pinkish buff when mature.

Stem very short, varying from 1-2 cm. long, and from 8-15 mm. thick, tapering downward; surface about color of cap, or with a more

pinkish tint, sometimes marked with darker blotches below, nearly smooth or with a thin scurfy tomentum especially below. Flesh solid, colored like that of the cap, but much firmer.

Spores pure white, warted, sperical to short elliptic, 4.6-6.4 x 6.4-9.2μ.

In spite of some peculiarities, this plant seems too close to *L. silicioides* Fr. to be separated, and I shall consider it a short-stemmed form of that species. In shape, texture of cap, and very short stem it resembles *L. atroviridis*. Distinguishing qualities are: absence of latex (or very scant); very short stem; surface of dense compacted fibers which are viscid when wet; inrolled margin covered when young with a roll of loose and not very long fibers which soon collapse; absence of zones, and yellowish orange color.

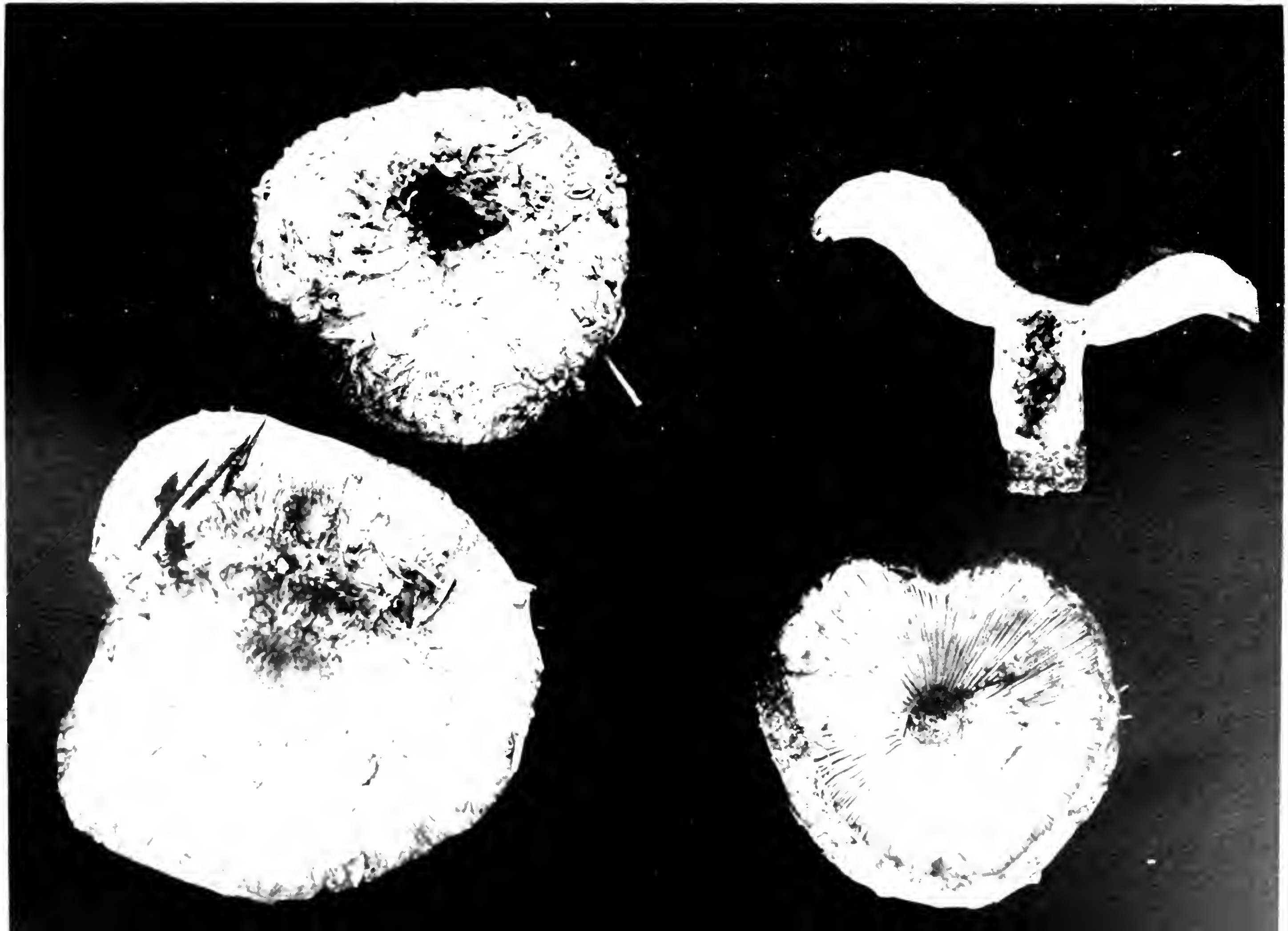
This is the first record of this European plant in the Southern States, and it has been found only a few times in the North. Distinctly a boreal species, occurring in cold weather in fall and spring, and always near pines on uplands.

972. Many plants in all stages, growing among pines in hillside pasture on west side of Glenn Burnie Farm, November 11, 1913. Two photos. These plants were found at the same time and place with a large number of plants of *Boletus brevipes*, and these two are remarkably alike in size, shape, length of stem, and place and time of growth. There had been hard freezing the preceding two nights and many of the plants were frozen when found. Microscopic examination of the flesh of the cap shows very loosely woven fibers with open places between them and almost no vesicular cells, latex quite absent at all stages in this lot, none being visible even with a lens in young plants just collected.

1441. In pines northeast of Piney Prospect, October 28, 1914. Photo.

3015. In sedge among pines near Cobb's Terrace, April 21, 1918. No visible milk, spores 5 x 6-7μ. These plants were typical and showed a very little milk, which was quite peppery and white and unchanging. The milk was so scarce as not to be noticed unless carefully looked for. Spores white, subspherical to elliptic, warted, one large oil drop, 4.2-5.1 x 5.1-7.6μ. In these plants the fibrous nature of the cap was not noticeable except near the margin. The surface elsewhere was shiny and nearly smooth from the collapsed and fused, viscid fibers.

PLATE 15



13. **Lactarius scrobiculatus** (Scop.) Fr.

PLATES 16 AND 40.

Cap up to 12 cm. broad, deeply depressed in center and finally infundibuliform, margin even, incurved, distinctly tomentose at first, glabrous or nearly so at maturity, surface rather light brownish-yellow or pale buffy-yellow, distinctly or scarcely zoned, the superficial layer a whitish, slightly shining material which seems collapsed in zones and areas, thus giving the surface a roughish appearance under a glass, viscid when moist; flesh rather thin, firm, white, turning yellow when cut, odor noticeable and rather soapy. Milk quite acrid, white, then changing quickly to sulphur-yellow.

Gills subdistant to rather close, pale creamy-flesh color, turning sulphur-yellow when cut, then brownish, slightly decurrent, none or few forked, 5-10 mm. wide in middle.

Stem 3-4.5 cm. long, tapering downward, 1-2.8 cm. thick in center, firm, hollow, surface glabrous, typically marked all over with more or less circular or elliptic brownish yellow pits that are usually of very variable size, surface between them a light cream color or pure white. Rarely the spots are absent, as in our Coll: No. 1863. The stem is frequently furnished with a distinct elevated ridge near the top which represents the collapsed fibers which connected it with the gills in youth.

Spores (of No. 2371) creamy white, distinctly warted, elliptic, 4.8-6.3 x 6.3-7.4μ.

Our Chapel Hill form of this species is a large squat plant that seems confined to pine or mixed pine and deciduous woods. The gills are not crowded and are slightly tinted with flesh-color.

1863. On rocky, wooded hillside, Rocky Ridge Farm. September 22, 1915. Photo. Spores 5-5.5 x 6.6-7.5μ. Stem not spotted.

1957. In rather dry soil, pine woods between Strowd's Spring and Howell's Branch, November 3, 1915.

1965. Under pines near old "Rock Quarry," November 7, 1915. Spores elliptic, tuberculate, 6.2-7.5 x 7-8.2μ.

2371. Pine woods (with oaks) southwest of athletic field, July 5, 1916. Spores creamy with a faint salmon tint, elliptic, tuberculate, 4.8-6.3 x 6.3-7.4μ. Gills subdistant, 10 cm. wide.

Asheville. Beardslee.

14. **Lactarius insulsus** Fr.

PLATES 17 AND 40.

Cap medium to large, usually about 7-10 cm. and up to 15 cm. wide, deeply depressed in center, smooth all over, moderately viscid when wet, varying greatly in color, deep orange to pale buff or straw color, conspicuously and regularly zoned, or very obscurely so, especially when old and wet, and in pale-colored plants (as in No. 1637). Flesh white when young, becoming buff in age, up to 6 mm. thick near the stem, firm; odor somewhat acrid, but not nearly so strong or of the same character as in *Lactarius coleopteris.* Milk white, rather slowly but very acrid, unchanging, sparse.

Gills ochraceous-buff, deeper in color than most other species, appearing somewhat decurrent by the shape of the cap, nearly equal in width their whole length, and about 4-7 mm. deep, of unequal length, rarely forked, rather inconspicuously veined, varying from moderately close to quite distant.

Stem 2.5-5 cm. long, varying much in thickness, pointed at base, light creamy-buff or with a flesh tint, often vaguely spotted, but not with the conspicuous pock marks of *L. scrobiculatus,* smooth, stuffed, or becoming hollow. There is usually a lighter colored ring at the top of the stem which may remain noticeable in the dried plants. This is not so conspicuous as in *L. coleopteris.*

Spores light cinnamon-buff, spherical to subspherical or short-elliptic, strongly warted and ridged, about 5.5 x 7μ.

This species can be distinguished in the field from *L. scrobiculatus* by the milk not turning yellow, the entire absence of tomentum on the margin, and the faint or absent pock marks on the stem; from *L. torminosus* by the absence of the heavy marginal tomentum of that species; from *L. chrysorheus* and *L. theiogalus* by the milk not turning yellow.

115. Battle's Park, September, 1908.

492. Near Battle's Branch, back of Dr. Pratt's, October 4, 1912. Photo.

1637. Under leaves in an old road in woods, Battle's Park, July 24, 1915. Photo. Spores light cinnamon-buff, nearly pale orange-yellow of Ridgway, subspherical, warted, 6.8-7.8μ.

1792. Mixed woods in pasture back of Pritchard's, September 16, 1915.

PLATE 16

LACTARIUS SCROBICULATUS No 1863

PLATE 17

LACTARIUS INSULSUS

1841. In woods east of cemetery, Rocky Ridge Farm, September 20, 1915. Milk white, unchanging, peppery, surface slightly viscid, smooth, orange-yellow, rather faintly zonate, odor faint.

1854. Deep woods near Battle's Branch, near Stroud's pasture, September 22, 1915. Cap cinnamon buff with lighter zones, not very viscid, stem long, not spotted. Milk white, unchanging, peppery, one plant just like the others, otherwise had distant gills from 2-5 mm. apart except on the margin.

2369. Deep woods near Meeting of the Waters Branch, July 5, 1916. Spores elliptic, warted, 4.8-5.9 x 5.9-7.4μ.

Blowing Rock. Atkinson.
Asheville. Beardslee.

15. **Lactarius trivialis** Fr.

PLATES 18 AND 40.

This is a very common, fairly large plant with cap up to 14 cm. (often much smaller), strongly depressed in center, smooth, not zoned, viscid, the margin strongly inturned until half grown; color grayish-lead suffused with liver color (fawn color of Ridgway), very pale where covered with leaves, in old age becoming sordid earth color.

Gills narrow, only 5 mm. deep, even in large plants, crowded, many short ones but none forked, color light creamy flesh, becoming yellowish-brown, turning smoky brown when bruised, and quite dark brown when old. Milk light creamy white, not changing, quite acrid or only moderately so, and often becoming so only after a quarter or a half minute, sparse or moderately plentiful, said to turn the gills glaucous green, but this is scarcely noticeable in our plants.

Stem solid, smooth, nearly white or lightly tinted like the cap or gills, unpitted, in large plants up to 8 cm. long and 3.5 cm. thick.

Spores (of No. 566) grayish brown (dust color), distinctly warted and ridged, short-elliptic, 7-8 x 8-10μ, not counting spines.

Flesh white, tinted like cap near surface, not changing color when cut.

119. Battle's Park, behind Dr. Wheeler's, near branch, September 21, 1908.
120. Woods south of Dr. Battle's yard, Battle's Park, September 18, 1908.
517. Woods near branch south of campus, October 7, 1912.

566. Near small stream south of campus, October 16, 1912.
770. "Fern Banks" along Bowlin's Creek, September 14, 1913.
772. Woods near Battle's Branch. Spores light buff (Ridgway).
1560. In deep woods by path along Meeting of the Waters Branch, June 19, 1915. Spores light ochraceous-buff (Ridgway), spherical, tuberculate, about $7.2 \times 9\mu$; cap light liver color on marginal part, pallid earth color in center.
1573. On ground in hollow below Stroud's Spring, June 25, 1915.
2141. Oak woods near northeast foot of Lone Pine Hill, June 18, 1916.
2531. Sandy mixed woods near branch below Meeting of the Waters, June 20, 1917. Photo.

Asheville. Beardslee.

16. **Lactarius coleopteris** n. sp.

PLATES 19 AND 40.

Cap up to 14 cm. broad, depressed in center, margin rounded, irregular, quite smooth, surface very slimy-viscid, deep reddish orange, no zones except a few faint ones near the margin, marked with low radial striae like a Russula stem. Flesh 5 mm. thick at stem, firm, brittle, white; cut surfaces, especially at the stem, after standing a good while, become more or less ochraceous and in places dull green. Milk white, unchanging, acrid, sparse.

Gills moderately crowded, of equal width all the way, ending rather definitely at the stem and slightly decurrent by a short line (they are usually curved to one side just before reaching the stem so that the lines do not run straight down the stem, but at an angle), a few forked near the stem, 4-5 mm. wide, whitish when young, then creamy buff, when wounded becoming a dull reddish-brown; fleshy-buff when dry.

Stem 3-4 cm. long, 2-3 cm. thick, tapering downwards, smooth, whitish or straw colored with buffy red stains, a few faint streaks, or spots, a large cavity in center. There is a pinkish white collar at the top about 3 mm. wide, which is easily distinct from the rest and does not change color.

Spores (of No. 1851) buffy-yellow, spherical, minutely warted, $5\text{-}6.3 \times 6\text{-}7.5\mu$.

PLATE 18

LACTARIUS TRIVIALIS. No. 2531

PLATE 19

LACTARIUS CALEOPTERIS. No. 1851. TYPE

This plant has a strong acrid odor like that of some beetles, much stronger than in *L. theiogalus* or *L. acris* or *L. insulsus*. In drying, the gills become a pallid-buff, and there is a distinctly lighter zone at the top of the stem where the pinkish-white collar has faded. It also differs from *L. insulsus* in its slimy, zoneless cap, pink collar on stem, and acrid odor. Also in *L. insulsus* the color of the dry gills is very different—a deep brownish-red with a distinct overcolor of old gold. From *L. hysgenus* it differs in its color, pink-collared stem, and acrid odor. It resembles *L. agglutinatus* in its somewhat rugose cap, and strong odor, but it differs from it in much deeper color, pink ring on stem, and more acrid odor, different color of gills in the dried plant, and absence of the squamulose appearance of the dried cap.

It is also near *L. affinis* Pk., but neither Peck nor Miss Burlingham mention the strong odor or pinkish collar on stem, and the spores are smaller and darker and the color of the cap deeper than they give for that species.

1851. On ground in edge of woods south of South Building, September 21, 1915. Photo. Type.

1842. Mixed woods east of cemetery, September 20, 1915. This was exactly like 1851 in every particular except that there was no trace of zonation on the cap. The same light color at top of stem, and gills bent sideways on reaching stem. Spores buffy-yellow (about maize-yellow of Ridgway), spherical, minutely warted, 5.4-7.2μ.

1873. In damp shaded place below Meeting of the Waters. These two plants were exactly like collection 1851. Cap 7 cm. broad, very glutinous, deep reddish-bay color; milk white, unchanging, very acrid; taste and odor strong and pungent like that of some beetles; white collar on stem just below gills; stem cavernous; spores buffy-yellow.

17. **Lactarius mucidus** Burl.

This species has so far been reported only from Vermont and from the mountains of North Carolina. As we have not found it in Chapel Hill, we take the following from Miss Burlingham (Mem. T. B. C. **14**:56. 1908):

"Pileus fleshy, rather thin, convex umbilicate, then plane, at length infundibuliform, warm-sepia (305 t. 2, 3) in the center, putty colored (311) to stone colored (312) on the extreme margin, azonate, very

viscid and shining when wet, glabrous, 3-9 cm. broad, margin even at first, slightly wavy and striate in old plants; gills white, scarcely changing color with age, staining blue-greenish-gray where the milk dries (249 t. 1), sometimes forking near the stem, close, adnate to slightly decurrent, acute at the inner end, up to 7 mm. broad; stem of the same color as the pileus or paler, tapering upwards, slightly viscid when wet, glabrous, sometimes with faint striae, stuffed, then hollow, 4-7 cm. long, 7-10 mm. thick at the top, 10-15 mm. at the base; flesh white, odor none; spores white, broadly elliptical, echinulate, 7-8μ x 8-9.5μ; latex white, drying blue-greenish-gray on the gills and the broken flesh, acrid.

"Hab.: Under hemlocks, in wet weather. Late August and September.

"DISTINGUISHING FIELD-MARKS: This species may be easily recognized by the contrasting dark-sepia color of the center, the whitish color of the margin of the pileus, and its slimy shining appearance, as well as by the blue-greenish-gray color of the dried latex. It closely resembles *Lactaria cinerea* Pk. in size and texture, but differs in the habitat, in the color of the pileus, and in the change in color of the more acrid latex. While *L. cinerea* is most abundant in August, *L. mucida* does not appear until late in August and is most plentiful in September. I have found it only under hemlock trees, while *L. cinera* seems to grow only under beech trees. From *L. trivialis* it may be distinguished by the white spores, the more lax flesh, and the absence of lilac tints in the color of the pileus, which does not become yellowish in fading."

18. **Lactarius circellatus** Fr.

We have not found this in Chapel Hill, and the following description is prepared by Mr. Beardslee. It has been reported heretofore in America only from Vermont:

"Cap fleshy, convex, then depressed at the center and infundibuliform, opaque and slightly tomentose, brownish-gray, with numerous narrow, darker lines which form eight to ten zones, margin even, incurved. Milk white, unchangeable, very acrid.

"Gills close, white, then dingy, forking and unequal.

"Stem short, equal, pallid.

"Spores subglobose, rough, 6-7μ long.

"The dull brown pileus and numerous zones mark it."

Asheville, in woods, not common. Beardslee.

19. **Lactarius agglutinatus** Burl.

This species has so far been found only in the "Pink Beds" on Mount Pisgah, and I give below the original description by Miss Burlingham (Mem. T. B. C. **14**:42, fig. 5. 1908):

"Pileus convex-umbilicate, then depressed in the center with the margin uplifted, at length infundibuliform, buff (309. t. 4) fading to buff (310) when mature, slightly zonate when young, scarcely so when older, slimy-viscid when wet, with subrugose elevations or papillæ showing through the gluten, appearing squamulose to squarrulose when dry, 6-10 cm. broad, margin involute and minutely pubescent at first, the pubescence becoming less noticeable as the margin unfolds; gills yellowish-buff (310 t. 1), some forking near the stem, close, slightly decurrent, 2-4 mm. broad; stem of the same color as the pileus or paler, sometimes spotted, equal or tapering downwards, viscid when wet, glabrous, firm as though solid, becoming spongy to hollow, 2.5-4 cm. long, 1-1.5 cm. thick; spores creamy-white in mass (10. t. 1. 2), subglobose, echinulate, 7-8μ; flesh white, odor somewhat like raw pumpkin; latex white, unchanging, acrid.

"Hab.: Among dead leaves, in rather sandy soil, oak-chestnut woods, frequently under the flowering dogwood. August and September.

"DISTINGUISHING FIELD-MARKS: The medium size, buff color, and the papilliform and rugose elevations showing through thick, glistening gluten when wet, and the squamulose appearance of the pileus when dry. One peculiarity of the pileus is that if it becomes wet again after having dried, the squamules swell up and the surface appears papilliform and rugulose as at first."

Pink Bed Valley. Burlingham.

20. **Lactarius lanuginosus** Burl.

PLATE 20.

Cap up to 7.5 cm. wide, deeply depressed in center, the margin inrolled until maturity, then expanded or uplifted so as to become infundibuliform, surface viscid, sparingly and rather coarsely tomentose all over, margin not most so and the tomentum fading away there towards maturity. Zoned with soaked ochraceous and lighter honey-colored tints. Flesh 6 mm. thick at stem, thinning regularly to margin, firm, nearly white, not changing when cut. Milk white and remaining so, sparse, slightly bitterish-astringent, but scarcely at all acrid, sometimes quite mild.

Gills narrow, scarcely 3 mm. deep, crowded, many short, none branched, a clear ochraceous buff at maturity, turning smoky-brown when bruised.

Stem 1.5-3 cm. long, 9-12 mm. thick at stem, tapering strongly downward, 4-5 mm. at base, surface pure white or stained with buff, *densely soft tomentose all over* or the central region becoming less tomentose in age. Flesh brittle, whitish, hollow.

Spores ochraceous-buff, spherical or subspherical, warted, one oil drop, 5.4-6.3μ in diameter.

Distinguished from all our species by white, unchanging, nearly mild milk; deep ochraceous-buff and crowded gills; short, white-tomentose, pointed stem. It has been found only on Mount Pisgah and in Chapel Hill.

559. Low place by Meeting of Waters, October 14, 1912.
569. Low woods near Howell's Branch, October 18, 1912.
1796. In low place in woods south of Peabody Building, September 15, 1915. Photo.
1839. Woods by branch south of Raleigh road, Rocky Ridge Farm, September 20, 1915.

Pisgah Forest, North Carolina, under oak, maples, alder, and rhododendron. Burlingham.

21. **Lactarius turpis** (Weinm.) Fr.

We have not seen this in Chapel Hill, but it is recorded from North Carolina by Schweinitz and has been found at Asheville by Beardslee.

PLATE 20

LACTARIUS LANUGINOSUS. No. 1796

The following description is from Miss Burlingham (Mem. T. B. C. **14**:44. 1908):

"Pileus fleshy firm, thick, convex-umbilicate, then plane to depressed in the center, yellowish-brown or umber, with olivaceous tinge, darker in the center, azonate, slimy-viscid in wet weather, glabrous or agglutinated-fibrous, 6-12 cm. broad, margin involute at first and yellow-villose, then glabrous; gills cream-colored, then darker yellow, becoming nearly black where bruised, then ash-colored from the spores, many forking near the stem, close, somewhat decurrent, 3-4 mm. broad; stem of the same color as the pileus, equal or slightly smaller at the base, viscid when wet, glabrous, smooth or somewhat scrobiculate, or sometimes merely spotted, spots becoming nearly black in dried specimens, firm, stuffed, occasionally becoming hollow when old, usually 3-4 cm. long, 1.5-2.5 cm. thick; flesh whitish, odor slight; spores white, globose to sub-globose, echinulate, 6.5-8μ; latex white, unchanging, acrid. Possibly edible.

"Hab.: On the ground in mixed woods, often near fir or spruce trees. August and September.

"DISTINGUISHING FIELD-MARKS: The yellowish-brown or olivaceous color of young plants and the blackish color of mature plants, the slimy condition of the whole mushroom in wet weather, the blackening of the gills with injury or in drying, and in many cases the grayish color due to the presence of the spores. The pileus may be covered with villose fibers which are closely stuck to the surface, and are not easily distinguishable, or it may be practically glabrous. The yellow down or villosity on the margin disappears in the mature plant, and is at no time conspicuous."

Middle district (Schw.) woods. Curtis.
Asheville. Beardslee.

22. **Lactarius speciosus** Burl.

PLATES 21 AND 40.

Cap up to 7.6 cm. in diameter, depressed in center, the margin strongly inrolled when young and deeply clothed with long, coarse tomentum just as in *L. torminosus*, remainder of cap more thinly

furnished with flattened fibers pinched up into scattered squamules which are somewhat concentrically arranged; color a soaked ochraceous or honey color with lighter zones and with faint heliotrope tints where bruised; not viscid. In mature plants the marginal tomentum collapses and is not so conspicuous as in *L. torminosus.* Flesh firm, brittle, white, turning rather slowly to a pretty heliotrope color when cut. Milk white and remaining so; usually mildly astringent, but very slightly acrid, or not at all so.

Gills narrow, broadest in center where they are 4 mm. deep, reaching the stem, but not decurrent except by a little tooth, many short, but no forking ones; cream color to maize yellow, turning heliotrope when wounded.

Stem up to 4.5 cm. long, firm, hollow, tapering slightly downward, faintly tomentose at very base, only obscurely spotted or more often marked by many large and small pock marks, which are brownish yellow (egg yellow when young) like deeper parts of cap; areas between pock marks are nearly white or light to strong heliotrope; flesh except the very dry inside turning heliotrope when cut.

Spores (of No. 2199) pure white, short-elliptic, papillate, 8.5-9.5 x 10.5-11.5μ.

This species is like *L. torminosus* in its white, unchanging milk and general appearance; it differs in nearly mild milk, strongly spotted stem, heliotrope change of color, less tomentose margin at maturity, and larger spores. It is like *L. scrobiculatus* in strongly spotted stem and not very fibrous margin, but differs in mild, unchanging milk and heliotrope change in flesh.

This species is so far known only from North Carolina, Virginia, and Tennessee.

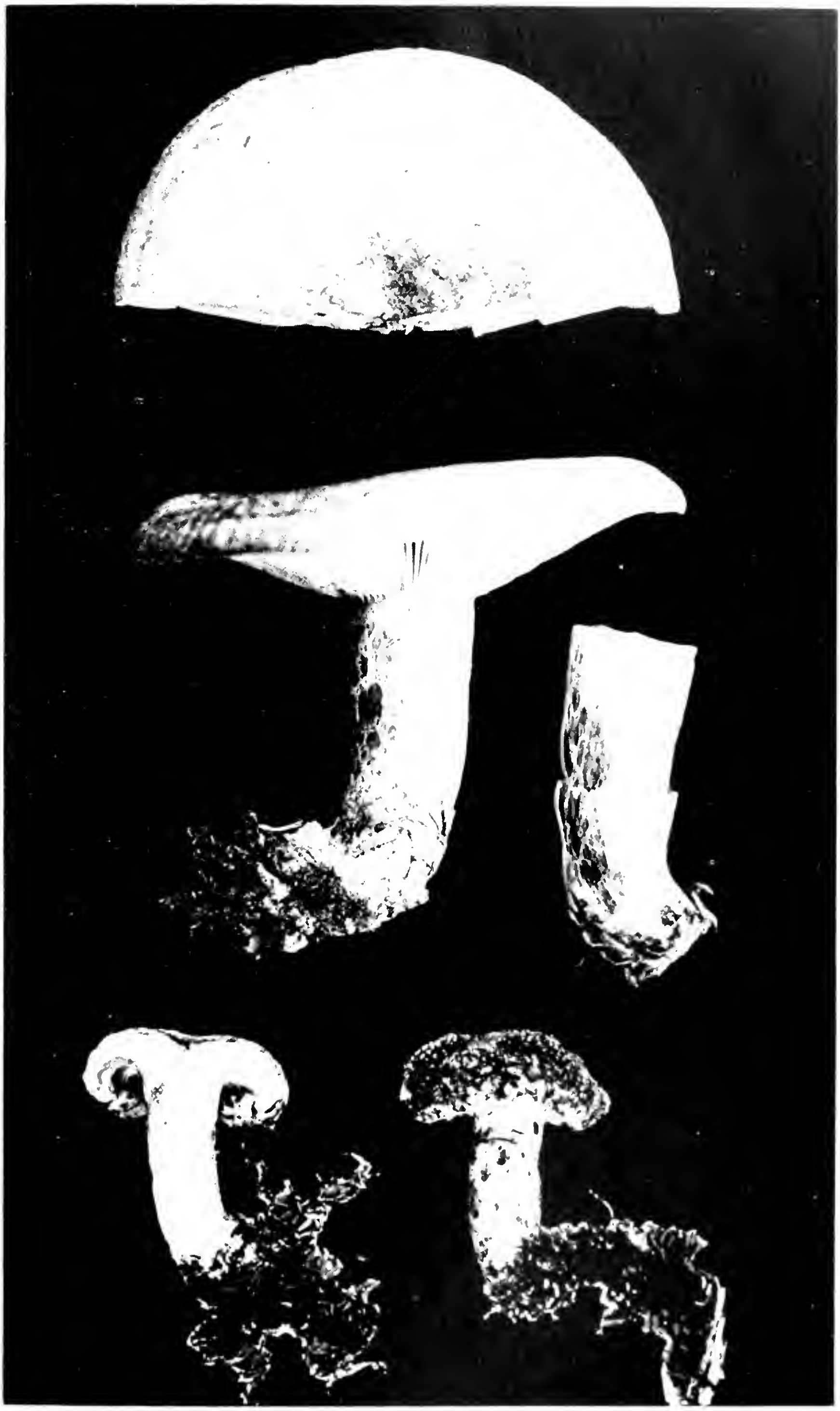
753. Woods east of Graded School, September 13, 1913.

1812. In moss by Howell's Spring, September 17, 1915. Photo.

1855. In deep woods by Battle's Branch, near Strowd's pasture, September 22, 1915. Stem strongly spotted, the surface between the ochraceous spots a *bright strong heliotrope.*

2199. Wooded pasture southwest of Mr. Pritchard's, June 22, 1916. Spores cream color, subspherical to elliptic, distinctly papillate, 7.4-11μ long.

PLATE 21



LACTARIUS SPECIOSUS
No. 753 (above) and No. 1812 (below)

2343. Woods near Meeting of the Waters, July 1, 1916.
2680. Mixed upland woods, Battle's Park, July 16, 1917.
2685. Battle's Grove (oaks), July 12, 1917.

Pisgah Forest. Burlingham.
Asheville. Beardslee.

23. **Lactarius croceus** Burl.*

PLATE 40.

Cap 6.3 cm. broad, depressed in center, the margin rounded and revolute until full maturity, quite smooth all over and decidedly viscid, when wet faintly many zonate, the zones not conspicuously spotted; color a rather light orange yellow. Flesh firm, rather brittle, about 6 mm. thick near stem and turning slowly to reddish yellow when wounded. Milk quite sparse, very acrid, most so after several minutes, white, its change of color not noticeable at once, but after a time the cut surfaces become a deep reddish yellow.

Gills moderately distant, a few forked or anastomosing, about 5.5 mm. wide beyond the middle, rounded at stem and attached, color creamy on side view, deeper on edge view, turning deep reddish yellow when bruished.

Stem 3.5 cm. long, 14 mm. thick at top, tapering downward, smooth, lighter than cap, a few scrobiculate spots which in this case were not deeper colored, surface becoming darker when handled; flesh firm, stuffed.

Spores light ochraceous, short-elliptic, tuberculate, 5.5-6.2x7.5-8.2μ.

This species may be distinguished from *L. chrysorheus* by the distant gills, darker and more viscid cap, and absence of fishy taste: from *L. theiogalus* by the much more acrid taste, distant gills, etc. It was found by Miss Burlingham in the Pink Bed Valley, North Carolina (elevation about 1,000 meters). For an illustration of the species see Mem. T. B. C. **14**: fig. 3. 1908.

2348. Woods near Scott's Hole, July 3, 1916.

* As *Lactaria crocea*.

24. **Lactarius delicatus** Burl.

This species is known only from Mount Pisgah, North Carolina, and the following is taken from Miss Burlingham's original description (Mem. Torr. B. C. **14**:40, fig. 4. 1908):

"Pileus fleshy, firm, convex, umbilicate, at length nearly infundibuliform, maize-yellow (36 t. 3), tinted in the center with yellowish-salmon (65), faintly but decidedly zonate, viscid and covered with gluten when wet, glabrous, 8-12 cm. broad, margin involute at first and covered with coarse short tomentum, then merely deflexed and glabrous; gills whitish, becoming maize-yellow with age, some forking near the stem, close, slightly decurrent, 5-7 mm. broad; stem whitish to maize-yellow tinted with yellowish salmon, more or less scrobiculate-spotted, spots of the same color as the rest of the stem or duller, equal or tapering downwards, glabrous, stuffed, becoming hollow, 4-5 cm. long, 1.5-2.5 cm. thick; flesh white, odor strong; spores tinted yellowish-salmon in mass, subglobose, echinulate, 7-8μ; latex white, becoming sulphur-yellow, acrid, scanty.

"Hab.: In sandy loam and dense shade, oak and chestnut woods. July and August.

"DISTINGUISHING FIELD-MARKS: The large size, the delicate yellowish-salmon tint over nearly the whole pileus, the faint nearly concolorous zones, the short tomentum on the margin of the immature pileus, the rather persistent viscidity, the lily shape of the mature pileus, and the change in the color of the latex."

Pisgah Forest, 1,000 meters elevation. Burlingham.

25. **Lactarius deliciosus** (L.) Fr.

PLATE 22.

A good-sized plant that is not rare with us in pine woods in fall. It varies considerably in color, but is marked by such distinctive characters as to be easily recognized.

Cap up to about 11 cm. broad, deeply depressed in center at maturity and striate on the very margin, or not striate until old, surface slightly viscid, smooth, but showing inherent fibers, sometimes not

PLATE 22

LACTARIUS DELICIOSUS. No. 601

zoned, again with obscure and distant zones. In color the cap may be yellowish or orange-clay or orange-gray and is nearly always marked with deep green zones and blotches towards and after maturity.

Gills a light orange-clay color, soon becoming duller and dotted with green, then all green in drying, when wounded turning immediately to the milk color, a deep orange and then green. Milk deep orange when fresh, then changing to green.

Stem about 3-7.5 cm. long and 1.5-2.5 cm. thick, nearly equal or tapering downwards, smooth, hollow in age, orange colored with nearly white apex and base (in No. 601), or it may be violet-purple, shading to blue or green below (in No. 107). Flesh a light creamy orange color and often with greenish tint next the gills, quite mild or slightly peppery.

Spores (of No. 601) yellowish-cream color, subspherical to short-elliptic, warted, 6.9 x 7.9μ.

Our plants might as well be referred, perhaps, to *L. Chelidonium* which seems poorly defined and doubtfully distinct from this.

As the name implies, *L. deliciosus* is widely known as edible, and is considered one of the best. For an illustration in color see Gibson, Our Edible Toadstools and Mushrooms, Pl. 18; also, N. Y. St. Mu. Ref. **48**: Pl. 29. 1897. 2nd ed.

107. Mixed woods, Battle's Park, October 28, 1910.
601. Low place in woods back of athletic field, October 21, 1912. Photo.
777. By Howell's Brook, September 16, 1913.
896. Woods, fall of 1913. Photo.
1284. On rocky hillside in pasture about one-quarter mile southwest of Graded School, September 29, 1914. Two photos.
1310. In pine woods along path south of athletic field, October 6, 1914.
1335. Scattered through Battle's Park in rather dry woods, north of cemetery. October 13, 1914.
1370. In thick woods, hillside, northwest of Glen Burnie Farm, October 17, 1914. Photo. Spores light cinnamon-buff, subspherical to short-elliptic, tuberculate, a large oil drop; 5.1-6.8 x 6.8-8.9μ.

Low and middle districts, pine woods. Curtis.
Asheville. Beardslee.

26. **Lactarius Chelidonium** Pk.

This species has so far been reported from North Carolina only by Atkinson. I am not sure that it is really distinct from *L. deliciosus.* The following description is by Miss Burlingham (Mem. Torr. B. C. **14**: 59. 1908):

"Pileus fleshy, firm, convex, then plane with the center more or less depressed, 'grayish yellow or tawny,' at length stained with bluish and greenish, usually with two or three narrow zones near the margin, slightly viscid when wet, glabrous, 5-8 cm. broad, margin involute at first and naked; gills saffron-yellow mixed with gray, sometimes forking, close, 'anastomosing or wavy at the base,' adnate, then slightly decurrent, narrow; stem of the same color as the pileus, nearly equal, glabrous, becoming hollow, 2.5-4 cm. long, 10-12 mm. thick; flesh whitish, staining saffron-yellow from the latex, then becoming bluish and at length greenish; spores yellowish, globular to broadly elliptical, echinulate, 7 x 8μ (9μ Peck); latex saffron-yellow, mild, scanty. *Edible.*

"Hab.: 'Sandy soil under or near pine trees' (Peck); also in dry spruce woods.

"DISTINGUISHING FIELD-MARKS: It is a paler yellow and duller in color than *Lactaria deliciosa,* the flesh is firm, the pileus scarcely viscid, the zones marginal, the stem short, the gills narrow, and the latex saffron-yellow rather than orange. It is usually found in dry woods in the vicinity of pine trees, while *Lactaria deliciosa* is most abundant in mossy wet woods, especially near hemlocks."

For an illustration of this species see Atkinson, Stud. Am. Fungi, Pl. 35, fig. 2. 1900; also, see N. Y. St. Mu. Mem. **3**: Pl. 53. 1900 (in color).

Blue Ridge Mountains, North Carolina. Atkinson.
Asheville. Beardslee.

27. **Lactarius subpurpureus** Pk.

PLATES 1 AND 40.

Cap 5.7 cm. broad, plane on margin, depressed in center, slightly viscid, light pinkish-buff (nearly white) with distinct zones of rather faint olive showing through; surface smooth and very much like

PLATE 23

LACTARIUS INDIGO. No. 135

L. deliciosus in appearance. Flesh firmly spongy, 4 mm. thick near stem, very light pinkish near the surface, deep wine color at gills, after several hours the cut surface becomes greenish.

Gills close, hardly decurrent, many short ones, none branched, 3 mm. deep in center, grayish-pink (hydrangea pink—Ridgway), much deeper colored in face than surface view, when wounded becoming greenish after several hours. Milk sparse, scarcely peppery, watery, deep wine color (dark vinaceous of Ridgway).

Stem very short and small, just as in *L. virescens*; 1.3 cm. long, 8 mm. thick, colored very much like the cap, with greenish and reddish stains and apparently solid normally, but hollowed by grubs.

Spores creamy white, oval, warted and ridged, one large oil drop, 5.9-6.8 x 6.8-8.5μ.

For other illustrations see Mem. Tor. B. C. **14**: fig. 8. 1908; also, N. Y. St. Mu. Rep. **54**: Pl. 70. 1902 (in color).

1246. On burnt-over ground under pines, edge of Raleigh road by Judge Brockwell's, September 23, 1914. Two photos and painting.

Blowing Rock. Atkinson.
Asheville. Beardslee.

28. **Lactarius Indigo** (Schw.) Fr.

PLATES 23 AND 40.

A beautiful and conspicuous plant, easily recognized by the fine indigo color of the cap and flesh and milk.

Cap up to 14.5 cm. broad, depressed in center, the margin turned down or nearly plane, often crenate and irregular; surface viscid, smooth, covered with a thin white layer through which the deep indigo color of the flesh shows in distinct zones of indigo, often with deep green areas where bruised. Flesh firm, deep indigo. Milk deep indigo, turning dark-green on exposure.

Gills close, attached, 3.5-4 mm. deep and nearly the same width throughout, distinctly indigo from the flesh showing through the whitish surface layer, turning deep indigo and then green when bruised. As the spores ripen a clay color is added to the gill surface.

Stem about 5-8 cm. long, usually, and 1.5-2 cm. thick, firm, hollow, color of cap, smooth, equal. Not rarely the stem is lateral and very short.

Spores warted and ridged, cream colored in mass, 5.6-6.7 x 7.8-8.2μ.

This species is edible, but is so coarse and so lacking in savor as to be of little value. While not abundant, it is not rare in summer and autumn.

111. Battle's Park, in woods just above Green Bench Spring. October 2, 1909.
112. Top of Lone Pine Hill, Glen Burnie Farm, September 19, 1908.
606. Near Meeting of the Waters, October 22, 1912.
742. Woods near branch east of Meeting of the Waters, September 13, 1913. Photo.
816. Woods above Howell's Spring, September 16, 1913.
1172. By path along branches north and west of Meeting of the Waters, July 24, 1914.
1345. In woods by branch 100 yards west of Meeting of the Waters, October 14, 1914. Photo. Spores subspherical to elliptic, tuberculate, a large oil drop, 5.1-6.4 x 6.4-8.5μ.
1365. Battle's Park, woods northwest of Brockwell's Spring, October 16, 1914.
1369. In thick woods, hillside northwest of barn, Glen Burnie Farm, October 17, 1914. Photo.

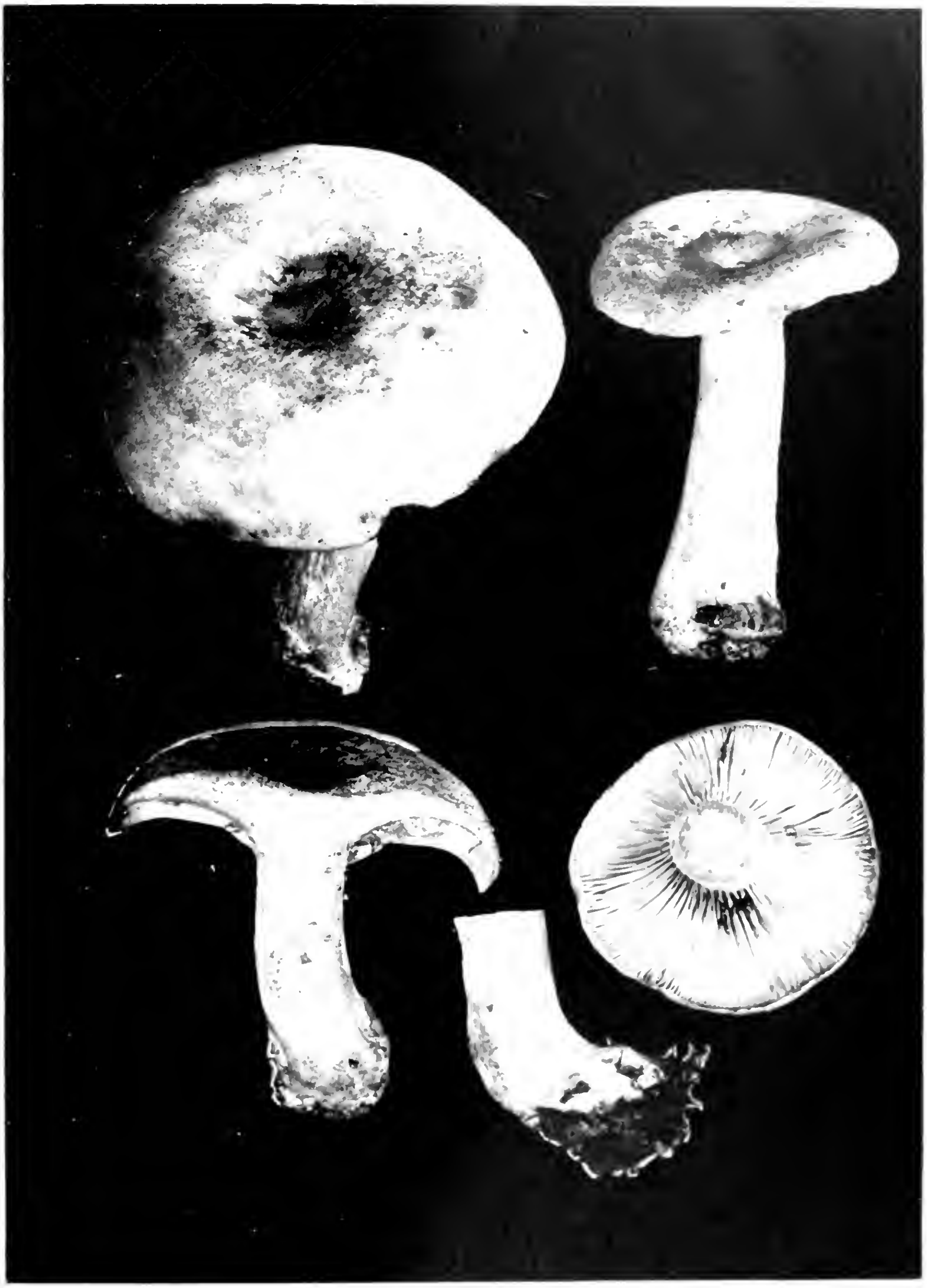
Common in woods. Curtis.
Blowing Rock. Atkinson.
Asheville. Beardslee.

29. **Lactarius theiogalus** (Bull.) Fr.

PLATE 24.

Cap depressed in center, almost infundibuliform, up to 9.5 cm. wide, in youth pruinose, quite smooth everywhere at maturity, or the center more or less pitted and roughened, viscid, pale creamy buff color with ochraceous and pinkish stains, very faintly or not at all zonate; margin nearly plane, often crenated and lobed. Flesh firm, then softer, white, turning a clear yellow with greenish tints when cut and after a time a deeper orange yellow, bitter and then mildly acrid; order perfumed-pungent when broken. In age when the milk disappears the flesh becomes a light flesh color and does not change when cut. Milk white, then deep yellow, bitterish, then moderately acrid.

PLATE 24



LACTARIUS THEIOGALUS (Nos. 1919 AND 1929)

Gills slightly decurrent, rather crowded, only 3-4 mm. wide, creamy at first then much deeper pinkish-cinnamon on edge view, a lighter buff color at a strong angle.

Stem about 2.5-4.5 cm. long and 1.2-1.8 cm. thick, sometimes enlarging downwards and tending to be fistulose, pruinose when young, smooth at maturity, but the base sometimes tomentose, whitish but stains of the cap color or color of cap all over, with small and usually inconspicuous scrobiculate marks, cavernous inside; flesh firm, brittle, turning yellow when cut.

Spores distinctly cinnamon (about light pinkish cinnamon of Ridgway), subspherical, warted, 5.8-6.3 x 5.8-7.2μ.

A small plant of low, damp woods, usually about 4 cm. broad and 5 cm. high. The species differs from *L. chrysorheus* (see No. 1838) in zones being much less clear and not spotted, in pungent smell, in much deeper colored gills and less acrid milk, also in spores being cinnamon and not white (Miss Burlingham gives the spores of both *L. chrysorheus* and *L. theiogalus* as white, but in our plants the spores of the latter are distinctly colored).

92. In woods north of cemetery, November 7, 1911. Spores creamy in bulk, subspherical, 4.6-5.5μ.

1188. Near branch southeast of Graded School building, July 22, 1914.

1196. In damp, cool hollow south of cemetery, July 23, 1914.

1800. On edge of pine woods near branch above Tenny's Ravine, September 17, 1915. Zones not dotted, spores spherical to subspherical, warted, one oil drop, 5.4-7.2μ in diameter.

1840. In damp woods by branch, north side of Rocky Ridge Farm, September 20, 1915. Photo.

1859. Woods north side of Rocky Ridge Farm, September 22, 1915. Just like 1840. Cap straw-yellow with faint zones of maize-yellow that are not dotted. Spores cinnamon, spherical to subspherical, warted, 5.4-9μ.

1919. Under pines in pasture near Graded School, October 25, 1915. Spores light buff, spherical to subspherical, warted, 5-8μ.

1929. In mixed woods, Battle's Park, October 25, 1915. Spores light buff, spherical, low warts, 5.1-7.2μ.

1944. In pine woods, near Meeting of the Waters, October 29, 1915.

Blowing Rock. Atkinson.
North Carolina (Pisgah Forest?). Burlingham.
Asheville. Beardslee.

30. **Lactarius chrysorheus** Fr.

PLATES 25 AND 40.

Cap up to 8 cm. broad, deeply depressed in center, often quite irregular and aborted on one side, margin strongly incurved until maturity and then not at all incurved, faintly or hardly at all tomentose when young, smooth afterwards, or tomentose on very margin nearly to maturity; surface viscid, quite smooth, pale maize-yellow or even lighter with faint zones of a dotted appearance. Flesh about 5 mm. thick near stem, soft but rather rigid and brittle; milk sparse, white, then greenish-yellow (about sulphur-yellow), very acrid and with a very disagreeable fishy taste, which is entirely different from the taste of any of our other species. The odor is similar, but not so strong.

Gills crowded, slightly decurrent, only 2-4 mm. wide, whitish when young, turning a rather light creamy buff, with a tint of pink in edge view.

Stem about 2.5-5 cm. long, 1.3-1.8 cm. broad at cap, tapering downward, whitish or colored like the cap, smooth, pruinose at top, marked by numerous, irregular, scrobiculate spots that are scarcely or not at all darker than the rest, hollow in center.

Spores (of No. 1838) white or faintly creamy, subspherical, warted, 5.8-6.3 x 5.8-7.2μ.

The distinctions between this species and *L. theiogalus* are not conspicuous. The gills in the former are lighter, and the zones on the cap are made up of dots, also the milk is more peppery and with a very bad fishy taste. The spores also afford a means of distinction; in *L. chrysorheus* they are essentially white, in *L. theiogalus* they are distinctly cinnamon.

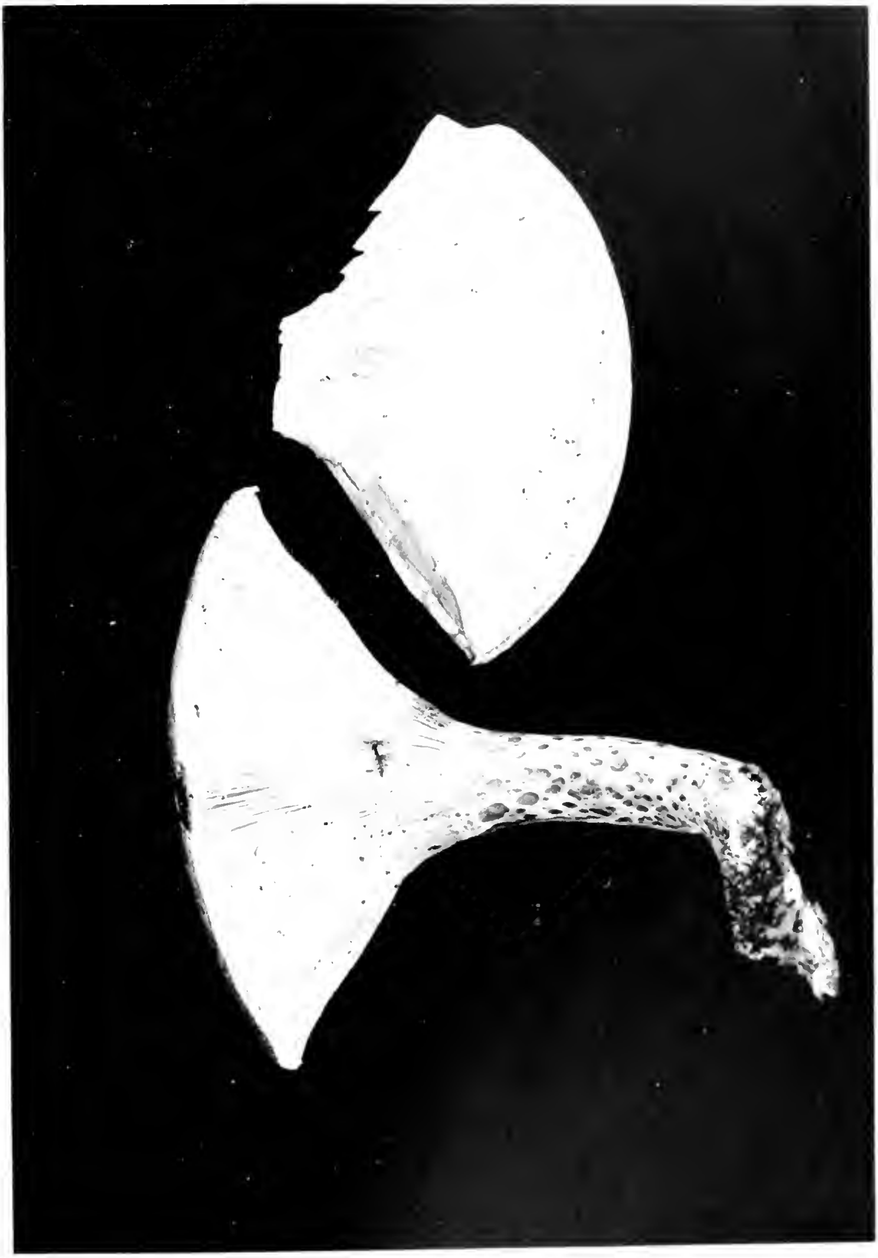
1661. Cool rich woods in Tenny's Ravine, July 27, 1915. Photo. Spores subspherical, warted, 6-7.3 x 7.5-8.2μ.

1838. In trash pile by road just east of cemetery, September 20, 1915. Photo.

2386. Thick brush, oak woods on Rocky Ridge Farm, July 18, 1916.

Blowing Rock. Atkinson.
Pisgah Forest. Burlingham.
Common in swamps. Curtis.
Asheville. Beardslee.

PLATE 25



LACTARIUS CHRYSORHEUS No. 1661

30a. **Lactarius chrysorheus.** Form A, with unchanging milk.

PLATE 40.

In Chapel Hill we have met with a plant in which the milk does not change color when exposed, but which cannot otherwise be distinguished from *L. chrysorheus*. Collection No. 774 was described as follows:

Cap up to 6.5 cm. broad, sharply depressed in center and sometimes with a deep sinus on one side, surface quite glabrous, a light brownish cream color with superficial layer of white slightly shiny material. Rather faintly zoned with brownish-cream and nearly white lines, the darker zones apparently formed by collapse of the white stuff, the zones, spotted. Flesh chalk white and not changing when cut. Milk white, not changing, moderately peppery.

Gills changing from white to a flesh-cream color, becoming brownish-yellow when bruised, narrow and close, many short ones and a few forking, slightly decurrent.

Stem white above, about color of cap elsewhere, marked with distinct pock-like pits which may or may not not be more deeply colored than the rest; hollow.

Spores light cream, subspherical, warted, one large oil drop, 6-7.5 x 7.5-9μ in diameter. The difference in size of the spores between this and the typical form as shown in Plate 40, figs. 20 and 21, is not significant, as the difference is not greater than normal in the species.

The smooth, zonate cap, and persistently white, acrid milk would indicate a relationship to *L. insulsus*, but the gills in that species are much wider and less close and very different in color in both the fresh and dry state, and the species is larger than *L. chrysorheus*. Our dried plants of No. 774 look exactly like dried plants of the latter species.

774. Near Howell's Brook, September 16, 1913. Photo.

31. **Lactarius quietus** Fr.?

PLATE 40.

Our one collection that I refer doubtfully to this species is a thin, broad, low plant, with much more the aspect of a *Tricholoma* than of

a *Lactarius*. Cap up to about 8.5 cm. broad, depressed in center, the margin bent down; surface smooth, dull, dry, and a uniform light buff. Flesh thin and transparent, white, the grub channels a creamy-yellow. Milk white, mild, not changing, not very abundant.

Stem only 3.3 cm. long, 1.3 cm. broad at top, tapering downward, very fragile, stuffed, hollowed by grubs.

Gills color of cap, 5 mm. deep, wavy, many short and few branched, reaching the stem but not decurrent.

Spores a warm buff color (Ridgway), spherical, tuberculate and ridged, 5.5-9.2μ in diameter.

The principal difference between our plant and *L. quietus* is in the lighter color of the former. This, however, may not be of much consequence. The dried plant is like specimens of *L. quietus* from Miss Burlingham, except that the spores average a little smaller in ours.

This plant seems to agree well with *L. pallidus,* but as there is doubt about the species being American and as I have no authentic specimens for comparison, the determination must be uncertain until further evidence.

789. Near Battle's Brook, September 19, 1913.

32. **Lactarius cyathulus** Fr.

L. paludinellus Peck.

This has so far been found in this State only in our mountains. The following description is by Miss Burlingham (Mem. Torr. B. C. **14**:66. 1908, as *L. paludinellus*):

"Pileus fleshy, thin, convex, then plane-umbilicate to depressed in the center, sometimes with a small umbo, brownish-drab (302 t. 2) to dark-fawn (307), expallent, slightly viscid when wet, glabrous, 12 mm. to 4 cm. broad, margin at length slightly striate; gills white to cream colored, becoming darker with age, pruinose, many forking near the stem, close, adnate or slightly decurrent, thin, up to 4 mm. broad; stem of the same color as the pileus or paler, nearly equal, glabrous, except at the base, which is slightly villose when growing in moss, stuffed, sometimes hollow, 2-3 cm. long, 3-4 mm. thick; flesh

white or tinted with the color of the surface; spores white, subglobose, echinulate, 6.5-8.5μ; latex white, unchanging, mild.

"Hab.: In marshy places in woods, in Sphagnum, or in decaying leaves.

"DISTINGUISHING FIELD-MARKS: The sordid-brown color or the mixture of brownish-drab and yellow-brown, which gives the moist pileus a mottled, streaked, and subzonate appearance, and the striatulate margin. The species is small and is rendered inconspicuous by its dusky coloring. It occurs only in densely shaded places."

Professor Beardslee has collected *L. cyathula* Fr. in Sweden, and writes me that he has no doubt that Peck's *L. paludinellus* is the same.

North Carolina (Pisgah Forest?). Burlingham.
Asheville, common. Beardslee.

33. **Lactarius Curtisii** n. sp.

PLATES 26 AND 40.

Cap 1.5-6 cm., usually about 3.5-5 cm. wide, deeply depressed (umbilicate) in center, the margin inrolled until maturity or after, sometimes expanded in age, rounded or nearly plane, often irregular and with a deep sinus on one side; surface quite smooth, dry, and chalky looking, azonate, chalk-white except for the brownish-yellow stains, turning light or orange salmon when bruised. Flesh quite firm and solid, about 8 mm. thick near stem in large plants, turning a deep orange salmon near the gills when cut, light orange salmon elsewhere, in age not turning salmon; mildly peppery when young, hardly so when old. Milk scant, a beautiful deep orange salmon, mildly peppery, disappearing in age.

Gills moderately close to somewhat distant, not forked, slightly decurrent, only about 3 mm. deep in large plants; color when young a fine orange salmon, after some time turning a smoky olive when bruised, fading to pallid ochraceous-buff with a tint of organge in age, smoky-olive in drying.

Stem very short, only 0.6-1.5 cm. long, and 7-10 mm. thick at cap, tapering downward, quite smooth and even, light orange salmon with

a whitish pellicle, hollow, often eccentric. Flesh like that of the cap, turning deep orange salmon near surface when cut.

Spores (of No. 1845) cream color, subspherical to elliptic, distinctly tuberculate, a large oil drop, 6-6.5 x 7.5-8.7μ.

This striking species grows on the ground in pine woods in the fall. It is probably nearest *L. chelidonium* Pk., from which it differs in the dry, white, zoneless cap and orange-salmon color of milk and flesh. It differs from *L. salmoneus* Pk. in the deep orange-salmon gills (salmon-orange to orange-cream of Ridgway), very short stem, absence of tomentum on cap, and entirely different habitat. This adds one more to the very small number of species in which the milk is bright colored from the first.

In looking over the copy, at the New York Botanical Garden, of Berkeley's manuscript notes on North American Fungi (mostly transcribed from notes accompanying the collection of Curtis and of Ravenel) I have recently discovered that this species was collected by Dr. M. A. Curtis (for whom I have named it) in South Carolina in the same kind of habitat. For some reason the species was never published, but Curtis' notes leave no doubt that he had our plant. These notes are as follows:

> "1364. (*Lactarius* near to 1293.) Cap clay-white, 1-1½ in. broad, smooth, fleshy (flesh thick, salmon-colored), margin involute when young, becoming depressed in center. Lam. unequal, attached, bright salmon-color, rather thick, straight, narrow, not crowded, occasionally forked, and in the older ones venosely connected. Sporidia white (?), stipe white or pale salmon colored, short (½ in.), 4 lines thick, hollow at the top, often eccentric. Among grass in rather damp pine sandy woods. Sept."

We also find the following note in the same manuscript:

> "2883. (*Lactarius deliciosus*, var. ut videtur vel nova sp.) Cap ½ in. broad, subviscid, with a thin white cuticle, not zoned, plano-convex, and umbilicate. Substance salmon colored, somewhat pungent. Lam. rich salmon colored, subdistant, not lactescent. Stipe 1 in. long, ½ in. thick, solid, whitish, fragile. Spores white!—Aug. Earth in pine woods."

1437. In grass among scattered pines in hollow exactly east of Piney Prospect, near Raleigh road, October 28, 1914. Photo. Spores 5.1-6.5 x 65.-9μ.

PLATE 26

LACTARIUS CURTISII N. Sp. No. 1845 TYPE

1845. On top of hill southwest of Sparrow's Mill, in pasture, with small pines, September 19, 1915. Photo. Type.

1857. In a water run in pines east of Piney Prospect, same place as No. 1437, September 22, 1915.

Hartsville, South Carolina: Under pines in low sandy woods near Prestwood's Lake, July 10, 1916 (W. C. Coker). This is in Darlington County, in which is also Society Hill, the place where Dr. Curtis first found his plants.

34. **Lactarius minusculus** Burl.

This is another species not reported in this State except from the mountains. The following is from Miss Burlingham (Mem. Torr. B. C. **15**:65, figs. 9 and 10. 1908):

"Pileus fleshy, thin, broadly convex, with a small umbo, becoming plane then somewhat depressed in the center, fulvous in the center, cinnamon (323. t. 1) toward the still paler margin, azonate, viscid in wet weather, sometimes shining with viscidity, glabrous, 1-3 cm. broad, margin minutely crenate sometimes sulcate, often slightly wavy, pruinose at first; gills whitish, seldom forking, close, adnate or decurrent by a tooth, broad for the thickness of the pileus; stem fulvous near the base but paler toward the pileus, equal, glabrous, sometimes tomentose at the base when growing in moss, stuffed, becoming hollow, 2.5-4.5 cm. long, 3-4 mm. thick; flesh isabelline-white; spores white, subglobose, slightly echinulate, 6-8μ; latex white, unchanging, acrid.

"Hab.: In moist woods, in moss or on decayed wood, under yellow birches, black gum, and black oak. July and August.

"DISTINGUISHING FIELD-MARKS: This species differs from all others in this group in its small size, crenate margin, and more acrid latex. It may be distinguished from *L. subdulcis* by its viscid pileus, and by being expallent. It is frequently solitary."

North Carolina, 1,000 meters. Burlingham.

35. **Lactarius cinereus** Pk.

PLATE 27

Cap up to 5.3 cm. broad, umbilicate or infundibuliform, the margin plane, or bent down and *distinctly striate*; surface viscid or scarcely

so, azonate, smooth but with the fine irregularities of a Russula stem, and in some plants inherently fibro-squamulose near the margin; color pale grayish buff (about tilleul buff of Ridgway) or a somewhat darker avellaneous color, often with a tint of lilac. Flesh white, toughish, about 3.5 mm. thick near center, thinning rapidly to 1 mm. or less. Milk watery white, scarcely peppery, bitterish, not abundant, scarcely any odor.

Gills moderately close, none forked, 5 mm. wide in middle, pointed at both ends, scarcely decurrent, nearly white when young, then pale fleshy buff, then slightly darker, pruinose with spores in age, dingy when wounded.

Stem slender, up to 5.5 cm. long, 8 mm. thick at cap, enlarging downwards or upwards, smooth above, somewhat fibrous below, color and texture of cap or paler. Flesh white, soft inside, and occasionally partly or decidedly hollow.

Spores (of No. 1928) about straw color, subspherical to short ovate, warted, 5.9-6.6 x 7.4-8.2μ.

311. Very low leafy place near Howell's Branch, September 29, 1911.

327a. In leaf mold near branch below Howell's Spring, October 4, 1911. Cap smooth, lead color with a tint of lilac, somewhat viscid. Spores subspherical, warted, about 4.5-5.4 x 5.5-6.5μ in diameter.

576. On ground in low place near branch below Howell's Spring, October 17, 1912. Photo.

773. Along Battle's Branch and Howell's Branch, September 16, 1913. Photo. This plant was just as above except cap was not viscid. Spores subspherical, one large oil drop, 5.5-7.4μ in diameter.

1928. In thin woods across Battle's Branch from Indian Spring, October 25, 1915. Photo. One cap had a smaller one growing on it.

Blowing Rock. Atkinson.
North Carolina (Pisgah Forest?). Burlingham.
Asheville. Beardslee.

36. **Lactarius helvus** Fr.

L. aquifluus Pk.

We have not found in Chapel Hill any plant that we could confidently refer to this species, and take the following from Miss Burlingham (Mem. Tor. Bot. Club **14**:74. 1908). For comparison of this and *L. rimosella* see under that species.

PLATE 27

LACTARIUS CENEREUS No. 576

"Pileus fleshy, fragile, convex, then plane to depressed, subumbonate, testaceous to isabelline, expallent, azonate, dry, the whole surface broken up into floccose-granulose squamules, sometimes rivulose, 5-15 cm. broad, margin involute at first, then spreading; gills white, then tinted with incarnate, finally yellow, often forking, close, decurrent, 2-3 mm. broad; stem pale-testaceous, equal, pruinose, pubescent at the base, stuffed, then hollow, 5-8 cm. long, 1 cm. or more thick; spores globose, echinulate, hyaline, 6-7μ; flesh of the same color as the pileus but paler, odor faint, sweet, persistent in drying; latex white, scanty, subacrid, more often watery and mild or subacrid. Edible.

"Hab.: In mossy rather wet woods or marshes. 'In pines, frequently degenerate in swampy places' (Fries).

"DISTINGUISHING FIELD-MARKS: The rather large size, the tawny buff colored, dry floccose-squamulose pileus, the usually watery milk, and the aromatic odor, which persists in drying."

Middle district (Schw.) woods. Curtis.
Asheville. Beardslee.

37. **Lactarius Peckii** Burlg.

PLATE 28.

Cap up to 11 cm. broad, depressed in center even when quite small, not umbonate, the margin strongly inrolled up to full growth and then mostly turned down, usually lobed and crimped at maturity. Surface rather roughly velvety, the margin distinctly tomentose when young. The color is very striking, a deep red brown (hazel, burnt sienna and chestnut brown), distinctly zoned or sometimes the zones scarcely visible in young plants. Flesh very firm, a light flesh-brown color, turning darker when cut. Milk very peppery, watery white, unchanging, rather scant.

Gills rather crowded, narrow, slightly decurrent, 2-3 mm. wide, color of cap and becoming a deep rich red-brown with age; pruinose at maturity, darker when bruised.

Stem quite smooth, tapering downward, 3-6 cm. long, about 1.2 cm. thick in center, solid and hard, color of cap, but somewhat lighter,

white tomentose at very base (most noticeable on part under the ground). Flesh like that of cap.

Spores white, spherical, tuberculate, a large oil drop, 5-6μ. See drawing.

Gregarious and often cespitose in low, mossy woods; not common.

113. By sphagnum moss bed west of athletic field, September 25, 1908.

1165. Just below sphagnum moss bed, east of athletic field, July 20, 1914. Photo.

2347. Damp woods by Meeting of the Waters Branch, near Scott's Hole, July 3, 1916. Photo.

Blowing Rock (as *L. rufescens* Morgan). Atkinson. (Morgan does not seem to have ever published his *L. rufescens.*)

Pisgah Forest. Burlingham.

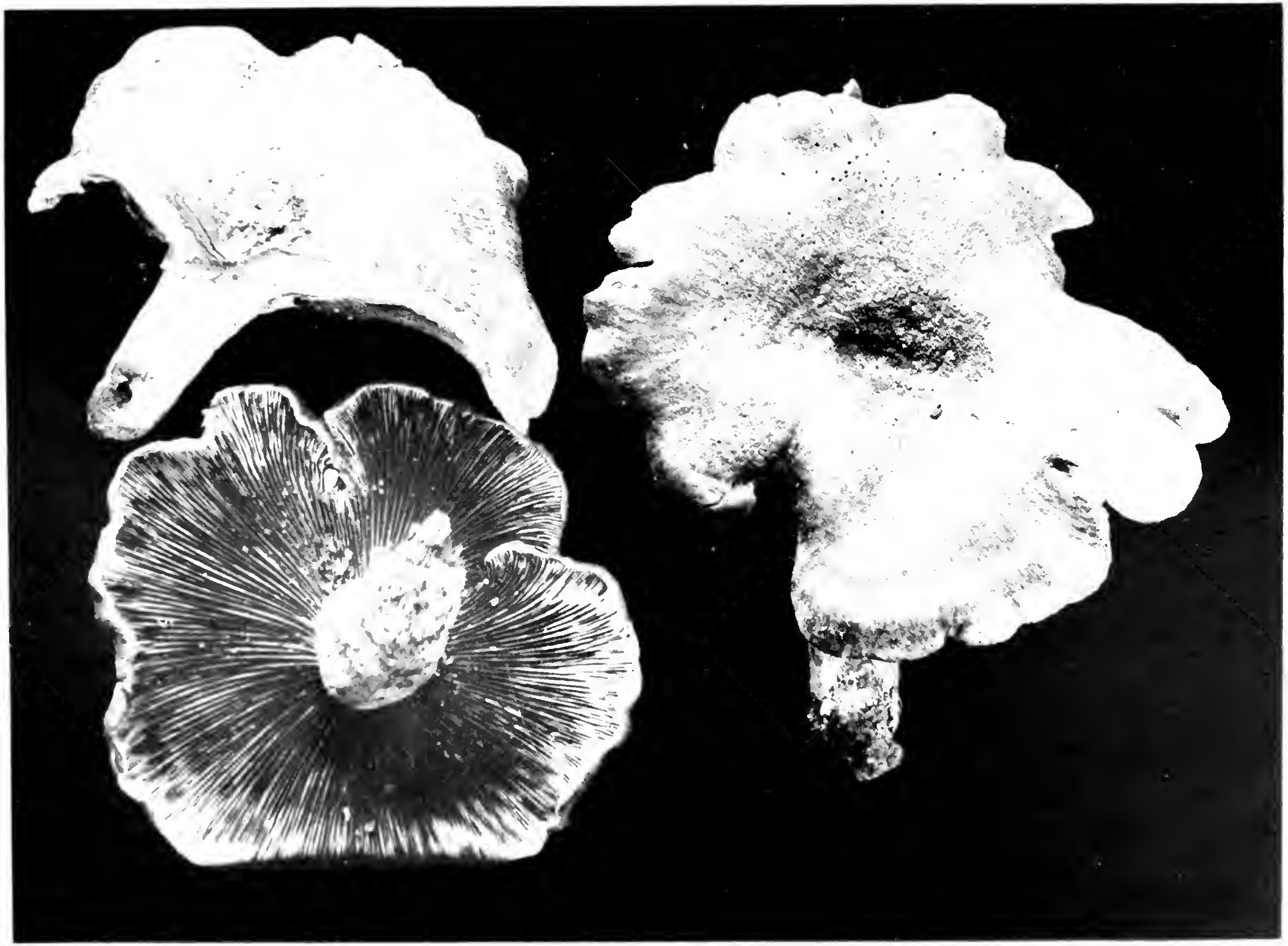
38. **Lactarius griseus** Pk.

Both Atkinson and Miss Burlingham have found this in the North Carolina mountains, but we have not met with the typical form in Chapel Hill. Miss Burlingham's description follows (Mem. Torr. B. C. **14** :80, fig. 14. 1908):

"Pileus fleshy, rather thin, firm at first, then lax, broadly convex, papillate, then depressed in the center, or at length infundibuliform, with or without papilla, varying from slate-gray (362) to smoke-gray (363), becoming yellowish with age (putty-colored, 311), azonate, dry, minutely tomentose, becoming floccose-tomentose, sometimes appearing squamulose to the naked eye, 1-5 cm. broad, margin involute, then spreading, entire; gills white, becoming cream-colored to honey-yellow, and pruinose, seldom forking, close, adnate to slightly decurrent, broader than the thickness of the pileus; stem of the same color as the pileus or paler, nearly equal, dry, glabrous except at the base, which is sometimes pubescent, stuffed, then hollow, 1.5-6 cm. long, 3-6 mm. thick; flesh white, unchanging, not aromatic; spores white, broadly elliptical, echinulate, 6-7 x 8-9.5μ; latex white, unchanging, slowly acrid.

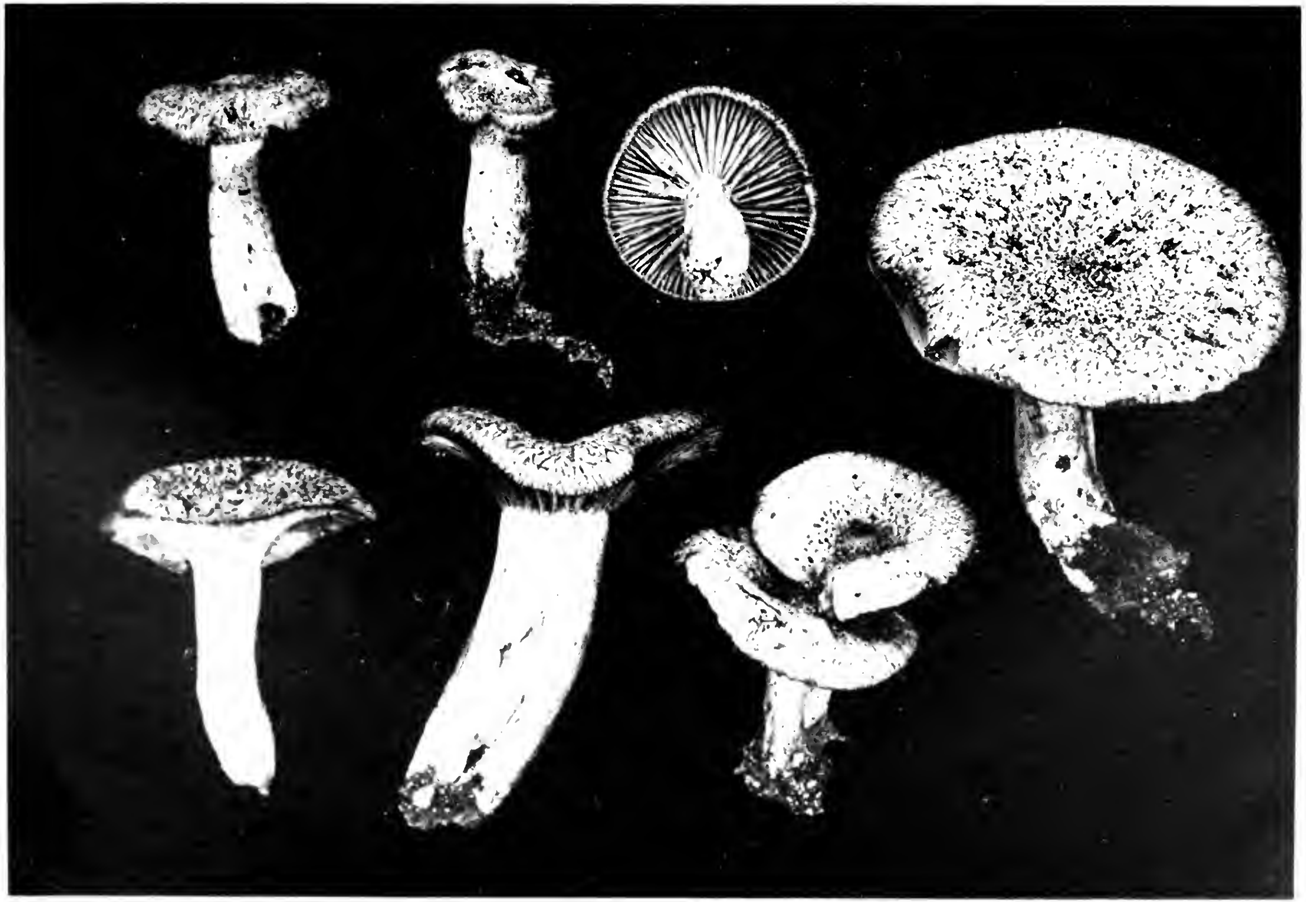
"Hab.: In moist, mossy places in either coniferous or deciduous woods, on the ground or on decaying logs. July, August, and September.

PLATE 28



LACTARIUS PECKII. No. 2347

PLATE 29



LACTARIUS GRISEUS. VINACEOUS FORM. No. 2560.

"DISTINGUISHING FIELD-MARKS: The gray, tomentose, azonate, expallent pileus, the glabrous stem, and the lack of odor. While the plants may be dark-gray at first, they usually become dull-yellowish or putty-colored when mature. This species is closely related to *L. mammosa* Fr., a European plant which has not been found in the United States. As figured by Fries, *L. mammosa* is a larger stouter plant than *L. grisea,* it does not become yellowish with age, and it has a white pubescence on the margin of the young pileus, and the stem is pubescent. *L. grisea* is at first uniformly gray and covered with gray tomentum, which later becomes floccose and less evident."

Blowing Rock, on a rotting log. Atkinson.
North Carolina (Pisgah Forest?), 1,000 meters. Burlingham.
Asheville. Beardslee.

38a. **Lactarius griseus.** Form A, with vinaceous cap.

PLATES 29 AND 40.

Cap up to 6.6 cm. broad, moderately depressed and at times with a small, sharp or bluntish papilla in the depression which does not disappear in age, shape irregular, wavy, the margin lobed and bent down, surface scarcely viscid, not zoned, very peculiar, squamulose-warted and roughened all over, the very center least so, the warts sharply pointed. Color grayish russet vinaceous (about light russet vinaceous or vinaceous drab of Ridgway), little changed in drying. Flesh dry, brittle, firm, about 5-6 mm. thick near stem, grayish-brown, with a tint of the cap color, not acrid, or decidedly acrid with a bitterish taste added, odor faint, sweet, and pleasant. Milk white and remaining so, sparse even in immature plants, mild or distinctly acrid.

Gills ending abruptly and somewhat rounded at stem, not properly decurrent, distant, none branched, short ones of two lengths, narrowed at both ends, bent, veined at cap, 4-5 mm. wide in center, color a clear cinnamon with a tint of the cap color, on drying becoming a pale buffy-gray, edge quite smooth and regular.

Stem about 2.5 cm. long, 1 cm. thick at cap, tapering downwards, pruinose above, color of cap or lighter, the base whitish. Flesh firm, brittle, color like that of cap, a large hollow in center.

Spores (of No. 1850) maize-yellow, subspherical, papillate and reticulated, one oil drop, 6.3-7.5 x 7.5-8.2μ.

Our Chapel Hill plant is exactly like *L. griseus* from Miss Burlingham, except for the vinaceous tint and larger size. The spores, also, are identical and differ from those of *L. helvus*. The color has remained constant for five years and may be said to characterize our form. The typical form is said to be slate-gray to smoke-gray, becoming yellowish with age, and its maximum size is less. At maturity the cap of the Chapel Hill form is azonate as described, but when young it may be distinctly zoned. Plants collected from the same spot (apparently the same mycelium) may be quite mild at one time and distinctly acrid at another; all of one collection are either mild or acrid. The plants, which are single or cespitose, are frequently attacked by a white mold which may completely cover them and ruin the larger part of a colony.

1850. Low, damp, deeply-shaded spot at base of Lone Pine Hill, September 20, 1915. Photo.

2305. Same place as No. 1850, June 29, 1916.

2350. By Meeting of the Waters Branch, near Scott's Hole, July 3, 1916.

2560. Low damp place at foot of Lone Pine Hill, June 24, 1917. Photo. Taste distinctly acrid and slightly bitter; growing in same place as plants of collection No. 1850, which were mild. Spores as in No. 1850, 6.6-7.5 x 7.5-8.5μ.

3114. Same spot as collection No. 1850 and identical in all respects.

39. **Lactarius plinthogalus** (Otto) Burl.

L. fuliginosus Fr.

PLATES 30 AND 40.

Cap up to 5.2 cm. broad, dull, dry, surface with texture of leather and with a bloom when young, no zones, flatly depressed in center, the margin strongly incurved in youth, rather light buffy-drab to much lighter straw-buff or white, tending to be somewhat rugose and pitted in center or all over. Flesh rather thin, nearly white, but usually turning quickly salmon or brick red when cut, sometimes scarcely changing. Milk white, unchanging or sometimes becoming

PLATE 30

LACTARIUS PLINTHOGALUS. No. 1834

salmon or brick red or pink when in contact with the flesh, mild when first tasted then after a moment becoming moderately or exceedingly peppery, sometimes remaining quite mild. Fries says that the milk is mild at first, soon becoming acrid, but after a time and in adult specimens sweet and pleasant.

Gills crowded or in some forms moderately distant, about 3-4 mm. wide, pointed at stem and somewhat decurrent, none forked, many short ones of about three lengths, at first nearly white, then light cinnamon-buff. When bruised they become brick-red or salmon-red in color.

Stem up to 3 cm. long and 8 mm. thick, nearly smooth, color and texture of the cap or lighter, nearly equal or tapering downward, stuffed with much softer material and often becoming hollow (as in No. 1593).

Spores (of No. 771) cinnamon-buff (Ridgway), spherical, strongly papillate and ridged, one large oil drop, 7.5-9μ in diameter, including the spines, most about 8.3μ.

771. Woods near Howell's Branch, September 16, 1913. Photo.

1593. Damp ground near Battle's Branch, July 9, 1915. Photo. Spores cinnamon-buff, spherical, 6.3-7.5μ in diameter. Milk white at first, then brick-red when touching flesh.

1628. Damp soil by Battle's Branch, July 22, 1915. This plant is typical of *L. plinthogalus*, but the latex is absolutely mild. Cap texture of leather, snuff-brown, zoneless, dry, wounds on any part turning salmon-red. Gills creamy, adnate. Stem even, texture of cap, somewhat lighter in color.

1772. Battle's Park in woods west of Brockwell's Spring, September 12, 1915. Milk mild.

1817. Damp soil, woods below Howell's Spring, September 20, 1915.

1834. In woods east of cemetery, September 20, 1915. Photo. Gills crowded, narrow; stem stuffed; spores cinnamon-buff, spherical, 6.6-10μ in diameter, most about 7.5μ, covered with a strong, blunt papillæ.

2233. Bank of New Hope Creek, below Durham-Chapel Hill bridge, June 24, 1916. Spores 7.3-8.5μ.

2538. By path along branch above Meeting of the Waters, June 22, 1917.

2577. Mixed woods, Battle's Park, July 2, 1917.

Asheville. Beardslee.

40. **Lactarius subplinthogalus** n. sp.

PLATES 31 AND 40.

Cap up to 10.5 cm. broad, usually 3-5 cm., moderately depressed in center, the margin rounded and somewhat irregular, or at times beautifully and regularly crimped; surface smooth, dull, minutely pruinose when young, scarcely so at maturity, marginal third with rather strong, radial, irregular pleats which extend in from the marginal crimps; color snuff brown, buffy-drab (avellaneous, Ridgway) to pale ochraceous-buff or occasionally even lighter (light buff, Ridgway). Flesh about 6 mm. thick near stem, tough, soft, whitish, turning rosy-salmon when cut, odor pleasant. Milk white, acrid, turning a deep rosy-salmon in contact with flesh and gills.

Gills very distant, somewhat decurrent, but ending abruptly and somewhat rounded at stem, none branching, not veined at cap, full length ones about 1-1.4 mm. apart at margin and 1-1.4 mm. deep. Between these are shorter ones of three lengths and three distinct widths, all bluntly rounded at the inner end. Color cinnamon-buff, turning rosy-salmon when cut.

Stem usually 3-4 cm. long, but at times up to 8 cm.; 7-15 mm. thick at cap, tapering slightly downward, smooth, about color of cap or lighter, flesh varying from solid and elastic and not noticeably stuffed in center (of the same firm consistency all through) to distinctly stuffed and sometimes covernous in age.

Spores (of No. 1835) cinnamon, spherical, covered with strong, blunt spines of varying lengths on the same spore, some 1.5μ long, others shorter, diameter with spines 10-12μ, most about 11μ.

This species is distinguished from *L. plinthogalus* by the larger spores, the solid stem, the very distant and deep gills, and the usually larger size of the plant. It is also usually darker than *L. plinthogalus.*

Miss Burlingham considers these plants as coming within the variation range of *L. plinthogalus,* and there is no doubt that this species is a very variable one. However, after careful observation of these plants in Chapel Hill, it seems to me that we have two distinct forms. We do not find confusing intermediates, and all our collections can be easily referred to one or the other group. I consider it less confusing,

PLATE 31

LACTARIUS SUBPLINTHOGALUS No. 2349

therefore, to treat them as distinct. On writing Mr. Beardslee in regard to this plant, he replied: "I have this the same exactly as you find it. I have noted the form you have as very different from the type of the species. I find one form taller than this with their crowded gills and your plant with the deep, distant gills, and I do not find intermediates. I find, however, forms larger than those you send with the same gills. I am inclined to think they should be separated. I do not find spores as small as Miss Burlingham's lower limits for them."

78. Low place east of athletic field, September 16, 1910.

1162. Swamp of New Hope Creek below Durham bridge, July, 1914. Spores spherical with blunt papillæ, average 11μ in diameter, including spines.

1835. In deep woods, north side Rocky Ridge Farm, September 20, 1915. Photo.

1862. Battle's Park, near Strowd's pasture, September 21, 1915.

2349. By Meeting of the Waters Branch, near Scott's Hole, July 3, 1916. Photo. Type.

2394. Woods at top of Lone Pine Hill, July 18, 1916. Margin beautifully crenated.

2436. Clay soil, mixed woods, Battle's Park, July 24, 1916. Gills and flesh slowly turn dull deep red when wounded; taste acrid.

2666. Low damp woods by branch below Howell's Spring, July 14, 1917. Stem in this specimen quite lateral as in Pleurotus.

Asheville. Beardslee.

41. **Lactarius ligniotus** Fr.

PLATE 32.

Cap 4.5-7 cm. broad, excentric and quite irregular, the margin broadly drooping, depressed in center or scarcely so, surface rugose all over, just as in *L. rugosa*, dresden brown all over, darkening to mummy brown in age, not zoned, dry, pulverulent with minute granules. Flesh about 5-8 mm. thick in center, quickly thinning towards the margin, rather spongy and elastic, pale cream-color, mild. Milk moderately plentiful, light pink or quite distinctly a clear *pink* color and not changing for a long time, then becoming sordid ochraceous like the wounded gills.

Gills distant, irregular, many short, some anastomosing near the margin and a few forked, about 3-4 mm. wide, slightly decurrent, pale creamy white, turning sordid ochraceous when wounded, and discolored in age.

Stem eccentric, 2.5-3 cm. long, 0.8-1.2 cm. thick, nearly equal, firm, stuffed, or cavernously hollow, surface even, pulverulent above, velvety below, colored like the cap but darker.

Spores yellowish, subspherical to elliptic, with a long mucro, very minutely papillate or papillate warted, 5.5-7.4 x 7.4-11μ.

A rare plant in Chapel Hill and represented so far by a single collection, which is of a short-stemmed form. The stem is said to reach a length of 8 cm.

2181. Damp soil by branch west of Meeting of the Waters, June 20, 1916. Photo.

Pisgah Forest. Burlingham.
Blowing Rock. Atkinson.

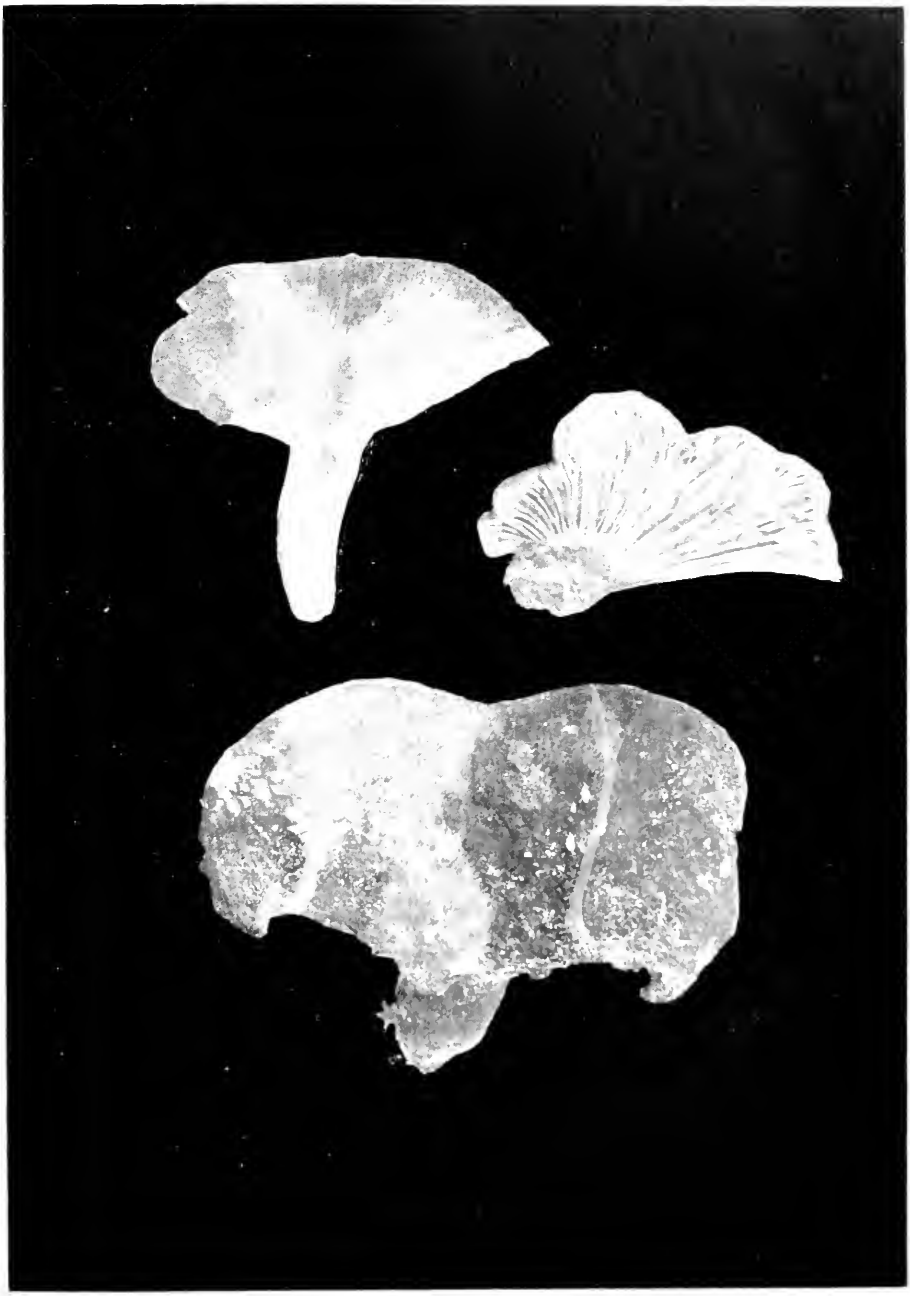
42. **Lactarius Gerardii** Peck.

The following is from Miss Burlingham (Mem. Torr. B. C., **14**: 87, 1908):

"Pileus fleshy, firm, convex at first, often with a small umbo, then plane or depressed, dark seal-brown, becoming golden-brown or umber, or sometimes paler, azonate, dry, surface velvety rugose radiately from the center, sometimes becoming cracked near the margin, margin even or wavy and irregular, often paler in color, thin, becoming extended; gills white then cream-colored, more or less interveined, distant, appearing more so in older specimens with somewhat irregular spaces, decurrent, not very thin, broad; stem the same color as the pileus, velvety to the touch, equal or ventricose, stuffed, then hollow, 2.5-5 cm. long, 4-20 mm. thick; flesh white, unchanging; spores white, globular, echinulate, 6.5-9μ; latex white, unchanging, mild, then slightly acrid. Edible.

"Hab.: On the ground in woods or in open groves. July to September.

PLATE 32



LACTARIUS LIGNIOTUS No 2181

"DISTINGUISHING FIELD-MARKS: This species is closely related to *Lactaria ligniota* Fr., but can be distinguished from it by the white spores, the unchanging color of the broken flesh or gills, and the more distant gills."

For an illustration in color see N. Y. St. Mu. Mem. **3**: Pl. 53. 1900.

Blowing Rock. Atkinson.
Pisgah Forest. Burlingham.

43. **Lactarius volemus** Fr.

L. lactiflua (L.) Burl.

PLATES 33 AND 40.

Cap generally more or less infundibuliform with various irregularities of the edges, surface smooth, not velvety, often with decided corrugations, particularly near the edge, and not rarely with cracks on the margin, color brownish-orange, or a much deeper brownish-red (Sanford's brown or cinnamon-rufous, Ridgway), sometimes very much lighter, not darker than light cream color. Flesh firm, white at first, changing when cut to a brownish-red. Milk very abundant, sticky, mild, white, and remaining white.

Gills at first creamy-white, turning a pretty creamy-yellow, and when bruised a dark, sordid brown, about 4-5 mm. wide, pointed at the stem, more or less decurrent, varying greatly in number, and so quite crowded or decidedly distant.

Stem 1.5-5 cm., usually 3-4 cm., long and about 1 cm. thick, very irregular, stuffed, surface pruinose except at base, where it is finely white velvety, colored about like the cap and lightest at the top.

Spores (of No. 104) white, globular, warted, 7.4-8.2μ in diameter.

This plant is nearest *L. corrugis*, but has not the fine tomentum of that species or the deeply colored gills when young. It is a good-sized, attractive, and rather common plant that is recorded among the best to eat. For an illustration in color see N. Y. St. Mu. Rep. **48**: Pl. 30. 1897. 2nd. ed.

95. Mixed woods south of Dr. Battle's in a rather low place with *Smilax rotundifolia*, September 25, 1911. No milk could be gotten from this individual, although at its perfection. Spores warted, 7.4-8μ.

102. Low woods east of the athletic field, September 25, 1908.

104. Battle's Park, September 14, 16, and 23, 1910.
327. Battle's Park, September 26, 1911.
802. Dr. Pratt's lawn, south side, September 21, 1913. Photo. Spores 7.4-11μ.
1007. Low woods west of athletic field, September 26, 1911.
1148. In sphagnum moss bed east of athletic field, July 10, 1914.
1192. Damp woods south of cemetery, July 22, 1914. A very light, pale-cream form. Spores 8.5-10.2μ.
1201. Hollow in woods south of the athletic field, July 23, 1914. Photo.
2205. Woods, Chapel Hill, June 23, 1916. Gills much more distant in one than in others.

Blowing Rock. Atkinson.
Common in woods. Curtis.
Mount Pisgah. Burlingham.
Asheville. Beardslee.

44. **Lactarius hygrophoroides** B. & C.

PLATE 34.

Cap about 5.5-8 cm. broad, deeply depressed in center, the margin arched and irregular, and sometimes prettily crenated; surface smooth or decidedly rugose, dull and distinctly pruinose, not viscid, about pinkish cinnamon to cinnamon (Ridgway). Flesh white, elastic, about 3 mm. thick near the stem, mild and odorless. Milk white, mild, not abundant.

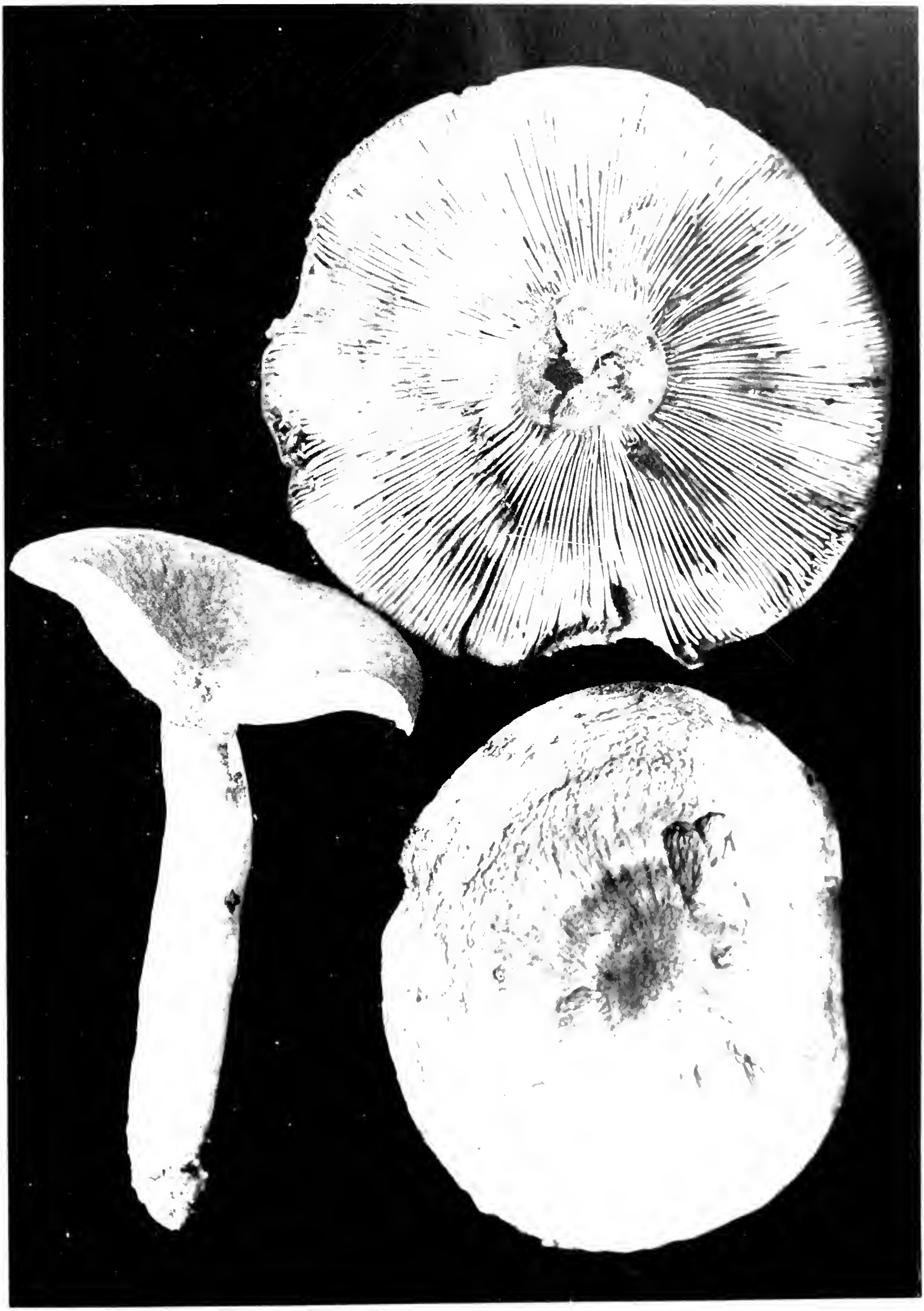
Gills distant, 6-7 mm. wide beyond the middle, pointed and decurrent at the stem, light yellowish-cream, thick and irregular, short ones near the margin, not changing when wounded.

Stem about 2.5-4 cm. long, 11-14 mm. thick at top, tapering downward, smooth, about color of cap, solid.

Spores distinctly roughened with low warts, elliptic, 5.5-7.4 x 7.4-11μ. They are exactly like the spores of the plant of this species in Miss Burlingham's exsiccati.

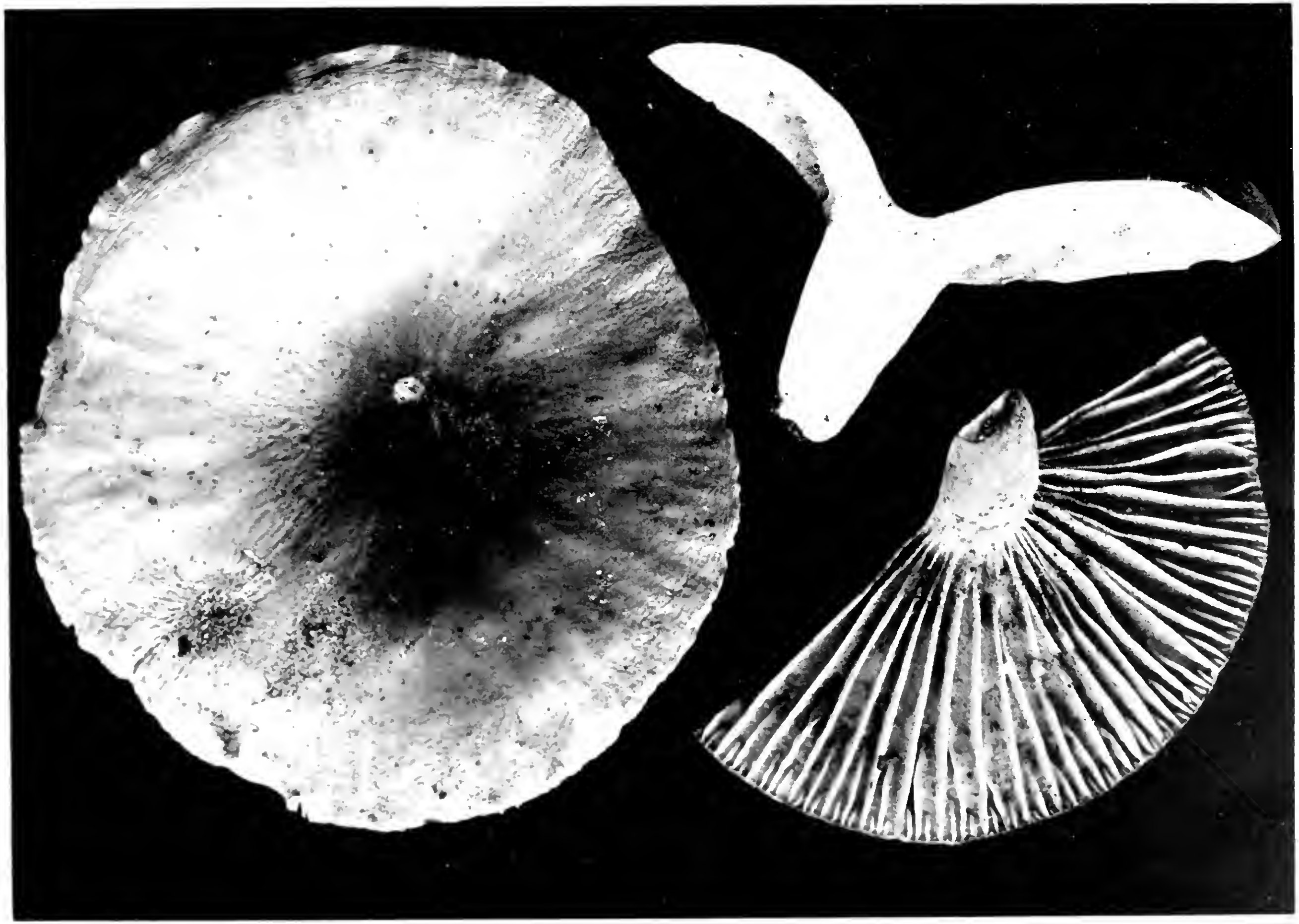
In drying the plant, especially the gills, has a strong tendency to become watery and moldy, contrasting in this way will the related *L. volemus* and *L. corrugis,* which dry readily. For an illustration in color see Mycologia **8**: Pl. 187. 1916; also, N. Y. St. Mu. Mem. **3**: Pl. 53. 1900 (as *L. distans*).

2344. Battle's Park, near branch, July 3, 1916. Photo.
2365. Damp soil along Meeting of the Waters Branch, July 5, 1916. Photo.



LACTARIUS VOLEMUS

PLATE 34



LACTARIUS HYGROPHOROIDES. No. 2365

45. **Lactarius corrugis** Pk.

PLATE 35.

Cap usually 8-9 cm. broad, depressed in center and margin nearly plane. Surface finely velvety-pubescent, the pubescence tending to lighten and obscure the color below; usually much corrugated, as in *L. volemus*, a very deep bay brown (chestnut) usually, but sometimes lighter, dry and without zones. Flesh white, turning quickly to a reddish-brown when cut. Milk white, bountiful, unchanging, very sticky.

Gills a deep fleshy yellow-brown when young, becoming a lighter golden-brown (antimony yellow of Ridgway) when mature, turning a deep scorched brown when bruised, slightly decurrent, moderately close, broadest near margin where they are 5 mm. deep.

Stem solid, 5.5-6.5 cm. long and 1.5-2.3 cm. broad; softly tomentose, color of cap, but lighter.

Spores white, spherical, warted, one large oil drop, 8.5-9.3μ.

The taste is mild and pleasant and the plant is very good to eat.

803. Woods south of athletic field, September 17, 1913.
1192. Low, damp woods south of cemetery, July 22, 1914. Color very light, a light cream or brownish-cream in places.
1193. Damp low woods south of cemetery, July 23, 1914. Two photos.
1205. Scattered along Battle's Branch, July 24, 1914.

Blowing Rock. Atkinson.
Pink Bed Valley. Burlingham.
Hartsville, S. C., low woods. Coker.

46. **Lactarius luteolus** Pk.

L. foetidus Pk.

PLATE 36.

Cap 3.5-6 cm. broad, not zonate, the center moderately depressed, the margin nearly plane with its edge incurved, rather irregular; surface covered throughout with a short, dense, felted, tomentum and viscid when moist, color light leathery tan, some parts darker than others. Flesh tough and firm, thick, 9 mm. thick near stem, white but quickly pinkish-brown when cut then deep dull brown,

a decided fungoid odor as in *L. volemus.* Milk abundant, mild, white and remaining so except when in close contact with the flesh, then undergoing the same changes.

Gills moderately close, adnate, simple or some forked near the stem, narrow, only 2 mm. wide, pruinose, pale cream at maturity, when bruised becoming quickly pinkish-brown then slowly deepening to blackish scorched brown.

Stem 2.5-3.5 cm. long, 1-1.5 cm. thick in middle, flaring at the top, tapering downward, color and tomentum exactly like that of the cap all over, brown where bruised; flesh solid, tough, and firm, changing like the cap flesh.

Spores white, subspherical to elliptic, distinctly papillate, 4.8-5.5 x 5-7.4μ.

This is new to North Carolina, having been reported in the South only from Tennessee and Mississippi. The cap is described as not viscid, but is certainly viscid when quite fresh in our plant. The abundant mild milk and quick change to brown show the kinship of the plant to *L. corrugis* and *L. volemus.*

1715. In sandy soil in woods near branch north of Meeting of the Waters, September 9, 1915. Two photos. Spores 5.4-6.8 x 5.8-7.2μ.

2817. By rock wall in sidewalk west of Professor Howell's yard, under white oak, July 30, 1917. Photo.

2820. In grass under oak in Professor Howell's lawn, August 3, 1917. Seven plants, 3.5-5.5 cm. broad, old ones with the margin elevated. Characters as in No. 2817.

47. **Lactarius lentus** n. sp.

PLATES 37 AND 40.

One plant. Cap 5.5 cm. broad, regular, flatly rounded, soaked looking in center where it is nearly glabrous but dull, and buffy ochraceous, the marginal half or third strongly rugose, the broad cracks showing the fibrous looking and lighter flesh, not at all viscid and not zoned. Flesh pure white, about 5 mm. deep at stem, rapidly thinning towards margin, very tough and firm; tasteless. Milk white, unchanging, mild, not discoloring the gills.

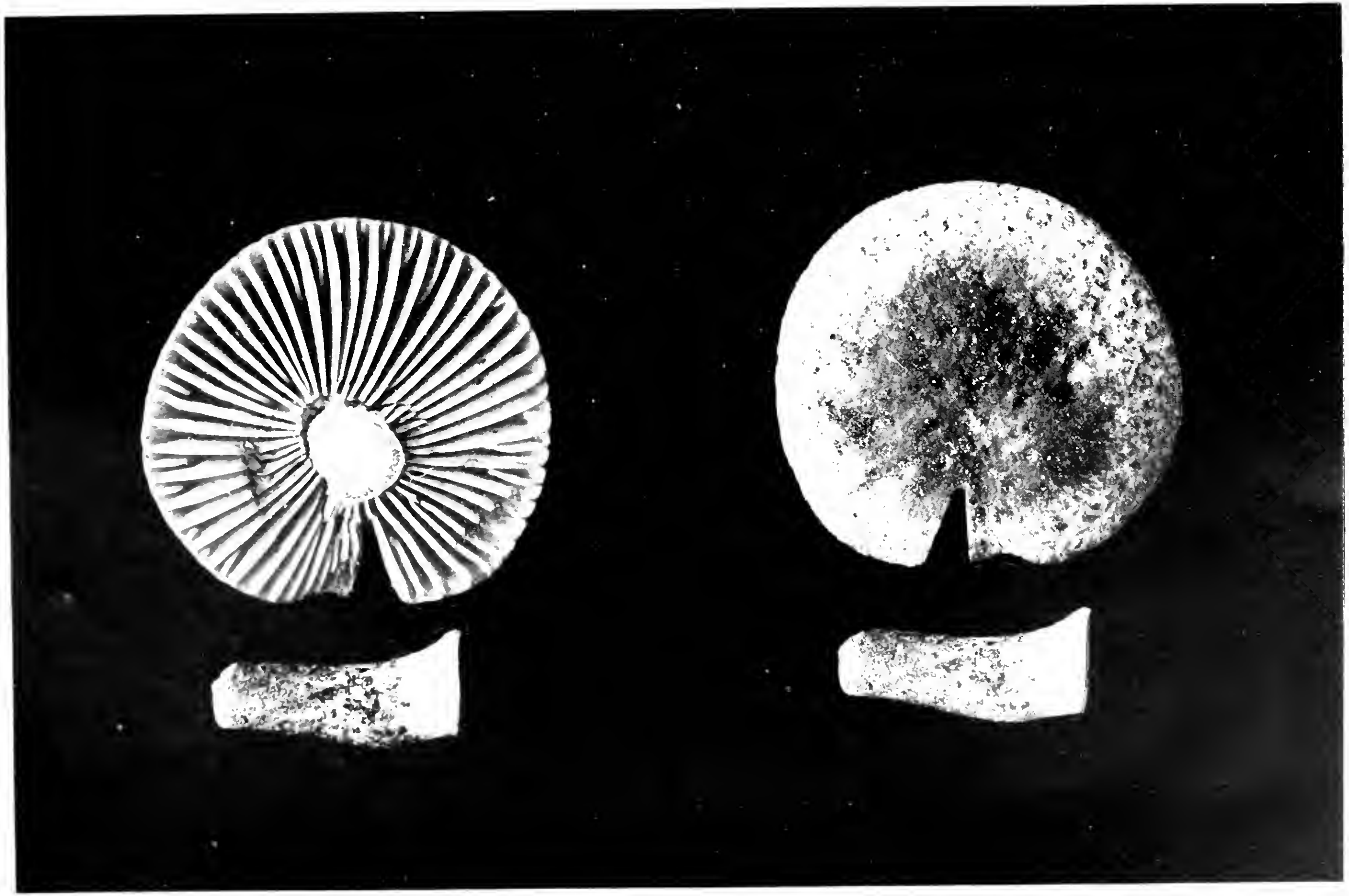
PLATE 35

LACTARIUS CORRUGIS. No. 1193

PLATE 36

LACTARIUS LUTEOLUS. No. 2817

PLATE 37



LACTARIUS LENTUS N. Sp. No. 2323

Gills very distant, some short marginal ones and a few branched near the stem, about 4-5 mm. wide, very thick, firm and tough, narrowly attached, not decurrent, not brown when bruised.

Stem 3 cm. long, 11 mm. thick at top, tapering downward, light and smooth above, somewhat scurfy cracked like the cap margin below and of the same color, texture quite firm, tough and solid.

Spores pure white, broad elliptic, minutely warted under high power, 3.7-4.8 x 5.5-7.4μ.

This is evidently in the Lactifluæ group, but differs from related species in the very tough and tenacious texture of all parts, the quite different spores, which are much smaller and smoother than in *L. hygrophoroides* B. & C. as it is represented in Chapel Hill and in Miss Burlingham's exsiccati.

2323. Woods near branch above Meeting of the Waters, June 30, 1916. Two photos. Type.

48. **Lactarius camphoratus** (Bull.) Fr.

We have not recognized this species at Chapel Hill, but it has been reported from North Carolina, and we include the following description, adapted from Miss Burlingham (Mem. Torr. Bot. Club **14**:98. 1908):

"Pileus fleshy, firm, rather thin, convex, often umbonate, at length expanded, depressed in the center, but the margin still arching, fulvous (308) to madder-brown (334), azonate, dry, glabrous, 1-4 cm. broad, margin inrolled and pruinose at first, not striate; gills whitish or flesh-colored (67), becoming reddish-brown, sometimes a few forking next the stem, close, adnate to slightly decurrent, rather narrow; stem of the same color as the pileus or paler, nearly equal, sometimes flexuous, glabrous, pruinose, smooth, firm to spongy, 1-3 cm. long, 3-8 mm. thick; flesh of about the color of the gills, unchanging, odor aromatic, becoming more pronounced in drying; spores white, globose, echinulate, 6-7μ; latex white, unchanging, mild, abundant. *Edible*.

"In woods, more abundant in moist mixed woods. July to October.

"This species is of about the size of *Lactaria subdulcis* and some-

times of nearly the same color, but usually it is a darker-fulvous or more red-brown, and the flesh is firmer. The odor is usually faint at first, but becomes strong as it dries. To me the odor is like that of slippery-elm bark. The pileus is polished in appearance and does not fade with age nor become rimulose.

"The European writers describe the pileus as zonate, but no zonate specimens have been reported in the United States."

Blowing Rock. Atkinson.
Mount Pisgah. Burlingham.
Low districts, woods, and thickets. Curtis.

49. **Lactarius rimosellus** Pk.

PLATE 38.

Cap up to 5 cm. broad, averaging much smaller (about 1.5-3 cm.), sharply umbonate usually, but in age depressed around the umbo; surface minutely subtomentose or plush-like, usually cracked into small areas and appressed scales, deep brick-brown (onion-skin pink to pecan-brown of Ridgway). Flesh firm, color of cap but lighter, thin, 1 mm. thick halfway to margin; odor aromatic, not like camphor, becoming more pronounced in drying. Milk watery-white, mild, unchanging.

Gills rather distant, attached, broadest at stem where they are about 2 mm. wide, slightly decurrent, tough and elastic, a deep rich red-brown and pruinose at maturity.

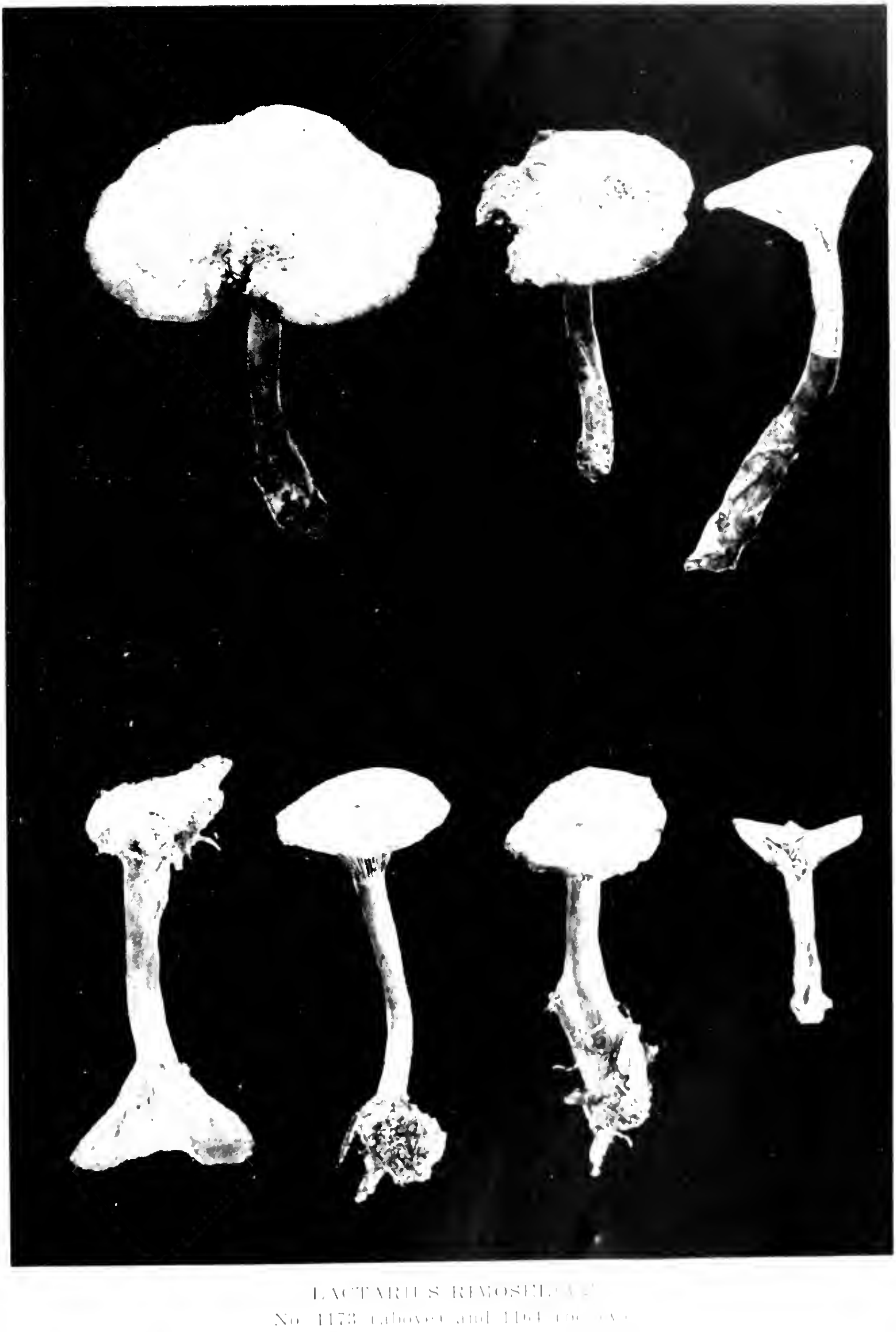
Stem smooth, cartilaginous, slightly tapering upward, about color of cap, but usually paler, lightest below, about 3.5 cm. long and 2-3.5 mm. thick in center, hollow.

Spores (of No. 1173) light creamy-brown, subspherical to elliptic, tuberculate to papillate, 5.5-7 x 6.6-8.2μ in diameter.

A pretty little plant, quite common in late June and July and less plentiful later. It is found in woods and groves among grass and moss, generally on the ground, but sometimes on rotting wood. It is plentiful in my yard under oaks.

Miss Burlingham has seen my two collections of plants and considers them *L. helvus*, but I cannot agree with this determination unless

PLATE 38



LACTARIUS RIMOSELLUS

No. 1173 (above) and 1164 (below)

L. helvus and *L. rimosellus* are the same. Compared with four good plants from the type collection of *L. rimosellus* that Dr. House has been so kind as to send me, the plants appear identical in every respect, as much so as if they had been gathered from the same colony. The spores, also, are exactly alike, being subspherical, most about 6.6-7 x 7.2-7.5μ, and with more spine-like papillæ than in those of *L. helvus* from Miss Burlingham, in which the spores are more elliptic and the warts more blunt and low. *Lactarius helvus* is, moreover, a larger plant than ours, and the gill color is different in the dry state. Peck's plants are decidedly odorous in the dried state, and so are ours (in this respect not differing from *L. helvus*, unless the odor be somewhat different). Plate 28 shows the largest plant of this species we have found in Chapel Hill.

76. Low places east of athletic field, September 25, 1908.
547. On mossy ground near Battle's Brook, October 10, 1912.
1164. Just below sphagnum moss bed, low woods, July 20, 1914. Spores 5.6-6.4μ. Photo.
1173. Near sphagnum bed east of athletic field, July 21, 1914. Photo.
1203. In several places along Battle's Branch, wet sandy places, just above water, July 24, 1914.
1594. By path along Meeting of the Waters Branch, near one-quarter mile west of Meeting of the Waters, July 9, 1915. Spores spherical, papillate (some less so), 6.3-7.2μ in diameter.
1753. Low, damp, shaded spot at base of Lone Pine Hill, September 12, 1915.
2357. On a rotting deciduous log, woods, July 3, 1916. Cap surface broken up into small squamulose-looking areas.

50. **Lactarius subdulcis** (Pers.) Fr.*

PLATE 39.

Cap 1.5-5.3 cm. broad, at times irregular, soon depressed in center, not papillate or umbonate, the margin elevated or nearly plane, in-

---

*__Lactarius__ sp.?

We have one collection of a tall slender plant growing on wood that we have not yet been able to determine. We have found no other *Lactarius* growing on wood except *L. rimosellus* (rarely), and that is easily different with its rimose and velvety cap and different color of gills, particularly when dry. *Lactarius subdulcis* has less spherical spores and different color (very different when dry), and *L. camphoratus* has a strong odor. *Lactarius lignyotus* var. *tenuipes* has been found on wood in spruce woods in Vermont, but

rolled at first, not striate or crenate, surface smooth, dull, slightly viscid when damp; color pinkish-tan or avellaneous to wood-brown all over or the center darker or mottled with brick-color. Flesh 2-3 mm. thick, tinted like the cap, rather brittle, not changing when bruised; odor faint but usually distinct, rather like dried apples, not stronger on drying. Milk white or watery-white, not abundant, mild on first tasting, then moderately and slowly acrid. Said to be mild or bitterish at times.

Gills crowded or scarcely crowded, adnate or slightly decurrent, none or a few forked, veined, 3-5 mm. wide, color of the cap or paler in youth, darker with age, on drying becoming very white-glaucous.

Stem 1-4 cm. long, 3-7 mm. thick, nearly equal, often compressed, color of cap, smooth, the base coarsely tomentose when in leaves, distinctly hollow except when young.

Spores (of No. 3019) white, tuberculate, 6-6.8 x 7.5-9.3μ.

By the glabrous cap, brownish color of all parts, tardily acrid milk and hollow stem this species may be distinguished. The milk is said to be mild at times. From Miss Burlingham's description our plants differ only in the slightly but distinctly viscid and non-papillate cap. The spores are exactly those of plants from Miss Burlingham, and the dried plants look alike. This is true, however, of *L. camphoratus* also, plants of which from Miss Burlingham having spores just like those of her *L. subdulcis*. In fact, no difference appears in the dried plants of the two species, the odor being the same so far as I can detect. From descriptions practically no difference appears except

---

that is very different. *Lactarius griseus* may also grow on decaying logs, but we have found it only on earth in Chapel Hill. The description of our plant follows:

Cap only 2-3 cm. wide, glabrous, not viscid, depressed in center, light ochraceous-buff to ochraceous-tawny. Flesh thin, firm, fragile, with a light tint of the cap color; odor none. Milk mild, sometimes so sparse as to be scarcely discernible even in very young plants.

Gills close, slightly decurrent, white then tan, with a tint of flesh color.

Stem very long and slender. 3-7 cm. long and about 5 mm. thick, ochraceous-tawny, lightly stuffed, base distinctly white villous, the hairs turning ochraceous-tawny in drying like the stem.

Spores white, spherical, a few short-elliptic, warted, 5.9-8.5 x 5.9-10.2μ. Distinctly more spherical than in *L. subdulcis*, Nos. 3019 and 3040.

PLATE 39

LACTARIUS SUBDULCIS. No. 3019.

that *L. camphorata* is said to develop a strong odor in drying, while *L. subdulcis* does not, and to be darker usually in color than the latter. All parts of *L. subdulcis* tend to become a darker brick color on old bruises and the old gills are often spotted with this color.

For an illustration in color see Mycologia **3**:168, Pl. 19. 1911.

3019. Pine woods by pond in front of cemetery, May 1, 1918. Photo. Small plants, cap 1.5-4.2 cm. broad, irregular; stem 1-2.5 cm. long, 3-7 mm. thick, hollow.

3040. Strowd's lowgrounds in moss, May 18, 1918. Plants larger, cap up to 5.3 cm. broad, wood brown to avellaneous. Milk white, slowly acrid, in age flesh barely acrid. Spores pure white, tuberculate, elliptic, 6 2-8 x 7.7-10μ.

3065. Strowd's lowgrounds, deciduous woods, May 22, 1918. Small plants; cap up to 2.5 cm. broad, stem 3 cm. long, center and one cap rugulose. All quite glabrous and depressed in center; no papilla and scarcely any odor. Spores pure white, tuberculate, elliptic, 6.5-7.6 x 7.6-9.7μ.

3094. Mixed woods back of athletic field, May 28, 1918.

Blowing Rock. Atkinson.
Mount Pisgah. Burlingham.
Asheville. Beardslee.
Common, damp grounds. Curtis.

CHAPEL HILL, N. C.

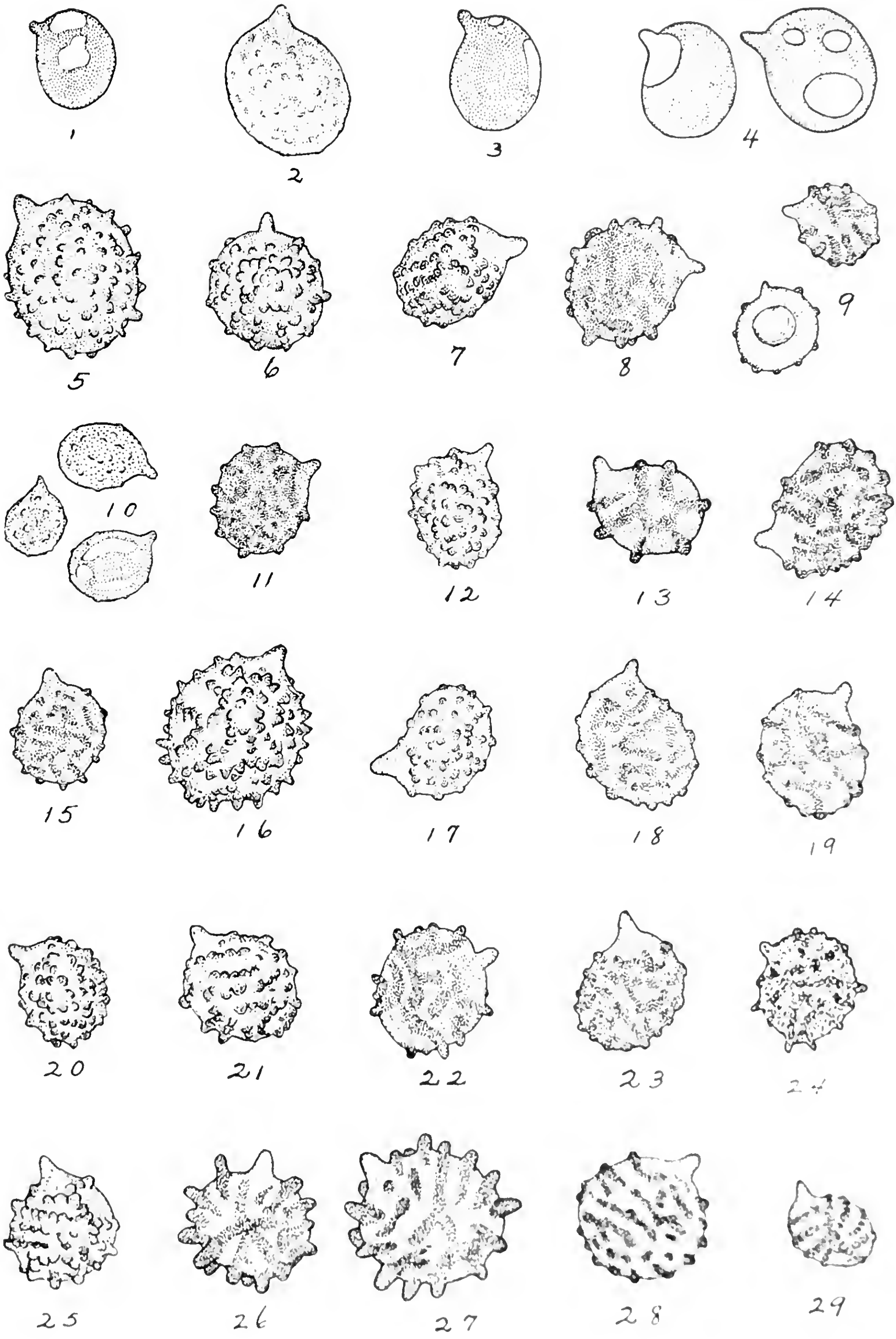
EXPLANATION OF PLATE 40.

(All figures x 2160.)

1.	Lactarius pergamenus	No. 904
2.	Lactarius vellereus	No. 1585
3.	Lactarius subvellereus. Form A	No. 1218
4.	Lactarius Allardii	No. 2329
5.	Lactarius deceptivus	No. 883
6.	Lactarius rusticanus	No. 1166
7.	Lactarius atroviridis	No. 790
8.	Lactarius torminosus	No. 2361
9.	Lactarius subtorminosus	No. 2813
10.	Lactarius furcatus	No. 2232
11.	Lactarius scrobiculatus	No. 2371
12.	Lactarius scrobiculatus	No. 1863
13.	Lactarius insulsus	No. 2369
14.	Lactarius trivialis	No. 566
15.	Lactarius coleopteris	No. 1851
16.	Lactarius speciosus	No. 2199
17.	Lactarius croceus	No. 2348
18.	Lactarius subpurpureus	No. 1246
19.	Lactarius Indigo	No. 1345
20.	Lactarius chrysorheus	No. 1838
21.	Lactarius chrysorheus. Form A	No. 774
22.	Lactarius quietus?	No. 789
23.	Lactarius Curtisii	No. 1845
24.	Lactarius Peckii	No. 2347
25.	Lactarius griseus. Form A*	No. 1850
26.	Lactarius plinthogalus	No. 2233
27.	Lactarius subplinthogalus	No. 2394
28.	Lactarius volemus	No. 104
29.	Lactarius lentus	No. 2323

*The drawing of this spore should be more clearly reticulated to accurately represent the majority.

PLATE 40



VOL. XXXIV SEPTEMBER, 1918 No. 3

JOURNAL

OF THE

Elisha Mitchell Scientific Society

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PROCEEDINGS OF SEVENTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT THE STATE NORMAL COLLEGE, GREENS-

The author of the article on pitcher-plants failed to receive proof, and consequently several typographical errors were overlooked, and a few references in the text to illustrations that were not used were inadvertantly allowed to stand. The cut of *Sarracenia purpurea* (Plate 2) is from a photograph by Dr. George E. Nichols of Yale University, and should have been so credited.

[illegible]

H. B. Arbuckle, Professor of Chemistry, Davidson College.
F. F. Bahnson, Ventilating Engineer, Winston Salem.
Mrs. F. C. Bivins, Instructor in Science, Durham High School.
J. H. Coman, Instructor in Electrical Engineering, Trinity College.
C. C. Logan, Extension Agronomist, State Agricultural and Engineering College.

The Elisha Mitchell Scientific Society

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PROCEEDINGS OF SEVENTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT THE STATE NORMAL COLLEGE, GREENSBORO, APRIL 26 AND 27, 1918.

In the absence of President W. A. Withers (detained at home on account of sickness) and Vice-President J. H. Pratt (in France engaged in the great war), the Secretary, E. W. Gudger, called together the Executive Committee composed of himself *ex officio*, H. C. Beardslee, and Bert Cunningham. It was noted that another member of the committee, H. R. Totten, was also absent engaged in war service.

On motion, H. C. Beardslee was elected President *pro tem.* for the meeting. The Secretary reported that the membership list on January 1, 1917, contained 88 names; that 13 members were lost during the year due to removal from the State, resignation, or nonpayment of dues, and that 10 new members were elected; the membership on January 1, 1918, being 85.

The following new members were elected:

H. B. ARBUCKLE, Professor of Chemistry, Davidson College.
F. F. BAHNSON, Ventilating Engineer, Winston-Salem.
MRS. F. C. BIVINS, Instructor in Science, Durham High School.
J. H. COMAN, Instructor in Electrical Engineering, Trinity College.
C. C. LOGAN, Extension Agronomist, State Agricultural and Engineering College.

The Secretary-Treasurer next presented his financial report, found elsewhere, and it was afterwards referred to the Auditing Committe for report.

The invitation of Trinity College for the Academy to be the guest of the College at the next annual meeting was unanimously accepted.

Immediately after adjournment of the Executive Committee, President *pro tem.* Beardslee called the Academy to order at 2:45 p. m., and appointed the following committees: Auditing, F. A. Wolf, E. E. Randolph, and J. S. Holmes; Resolutions, E. Oscar Randolph, Bert Cunningham, and A. S. Wheeler; Nominations, J. J. Wolfe, W. C. Coker, and J. F. Lanneau.

The reading of papers was then begun and carried steadily forward until the Academy adjourned at 5 p. m.

At 8:15 p. m. the Academy reconvened in the physics lecture-room of McIver Building. Owing to the absence of President W. A. Withers, the presidential address, "Gossypol," had to be omitted. However, Professor W. C. Coker gave two papers with lantern-slide illustrations, "*Azalea atlantica* and variety" and "A Visit to Smith's Island." This island is of interest, since, situated at the mouth of the Cape Fear River, it is the northern limit of a number of interesting biological forms, the palmetto palm, for example.

The Academy then adjourned to the first floor of the Student's Building, where an informal reception was tendered the members of the Academy by the Faculty and the members of the Senior Class belonging to the Science and Home Economic Courses.

The Academy was called to order at 9:10 Saturday morning, and immediately went into annual business session. The minutes of the last meeting were read and approved. The Secretary-Treasurer then gave his report on membership, elsewhere noted. He next read his report of the financial condition of the Academy. This the auditing committee found correct, and it was ordered printed.

Report of E. W. Gudger, Treasurer, 1917-1918

RECEIPTS

Balance last audit	$ 179.86
Dues since last audit	94.11
Interest savings bank acct.	5.31
Total receipts	$ 279.28
Less expenses	89.24
	$ 190.04

EXPENDITURES

Proceedings, 1917	$ 75.00
Printing	4.75
Postage and telephone	4.19
Clerical services	1.00
Secretary's dues	1.00
Secretary's expenses to Chapel Hill meeting	3.30
Total expenditures	$ 89.24

RESOURCES

Savings bank balance	$ 136.63
Checking bank balance	53.41
Total	$ 190.04
Dues unpaid (about)	$ 17.00
Stamped envelopes (about)	3.50
Estimated resources	$ 210.54
Estimated debts	82.00
Estimated balance	$ 128.54

OUTSTANDING DEBTS

Proceedings, 1917	$ 75.00
Printing	4.00
Miscellaneous (about)	3.00
Total (about)	$ 82.00

The Secretary then reported his inability to attend the Atlanta meeting last October of the Southeastern Association of Colleges and Secondary Schools, to which he had been appointed a representative of the Academy.

The Committee on Science Teaching in North Carolina High Schools next made a partial report, which, in connection with the papers read by E. W. Gudger at the preceding session, on the "Entrance Requirements in Science of the State Normal College," led to considerable profitable discussion. Finally the committee was reconstituted as follows: A. H. Patterson, H. B. Arbuckle, J. J. Wolfe, and S. J. Marion, continued until next year, and asked to bring in a full report.

The Nominating Committee next reported, and the following officers were elected for 1918-19:

President—E. W. Gudger, Professor of Biology, State Normal College.

Vice-President—H. B. Arbuckle, Professor of Chemistry, Davidson College.

Secretary-Treasurer—Bert Cunningham, Assistant in Biology, Trinity College.

Executive Committee (additional members)—Rev. George W. Lay, St. Mary's School; Miss Gertrude Mendenhall, State Normal College; Prof. J. J. Wolfe, Trinity College.

The Committee on Resolutions next reported, as follows:

Resolved, That we extend our heartiest sympathy to President W. A. Withers, who was prevented from attending this meeting by serious illness in his family.

That we extend our congratulations and best wishes to our members who have entered Government service.

That we pledge our support to the Government in all of its efforts to prosecute the war.

That we stand ready to aid our people in realizing and properly utilizing our peculiar economic and industrial advantages.

That we extend to the President, Faculty, and students of the State Normal College our sincere and united thanks for the kindness, courtesy, and cooperation shown us during our meeting here. And that we particularly wish to express our appreciation of the delightful reception given us on Friday evening, and of the equally pleasant entertainment at luncheon on Saturday.

At 9:45, after being welcomed to the College by President Foust of the Normal College, President *pro tem.* Beardslee presiding, the reading was begun of papers in the joint meeting of the Academy and the North Carolina Section of the American Chemical Society.

After the reading of chemical papers of general interest, at 10:30 the Chemists withdrew for their special meeting and the Academy took up its program.

At 12:50 both bodies adjourned and were entertained at luncheon by the College in the dining hall.

Reconvening at 2 p. m., the Academy finished its program and adjourned at 2:30.

The war conditions were clearly shown in the smaller number of papers on the program, and in the large number of members now in War service—10 out of an enrollment of 85—while others have gone to other States to engage in munitions and other war manufacturing. The attendance at the meeting was 24, and the considerable discussion of papers made possible by the smaller number of titles added much to the pleasure and profit of the sessions. Few more enthusiastic meetings have been held.

The membership of the Academy at the present time is 80. Those present at the meeting are marked *, and those in military service and carried as inactive members are marked *a*.

Andrews, T.
*Arbuckle, H. B.
*Bahnson, F. F.
*Balcomb, E. E.
*Balderston, Mark
*Beardslee, H. C.
Bell, J. M.
*Bivins, Mrs. F. C.
Bottum, Miss Frances
Brewer, C. E.
Brimley, C. S.
Brimley, H. H.
Bruner, S. C.
Cain, W.
Clapp, S. C.
*Cobb, Collier
Cobb, William B.
*Coker, W. C.
Collett, R. W.
Coman, J. H.
Cunningham, Bert
Detjen, L. R.
*a*Dixon, L. F.
*a*Dobbins, C. N.
Downing, J. S.
Edwards, C. W.
Farmer, C. M.
*a*Feild, R. H.
*Gudger, E. W.
*a*Harley, G. W.
Henderson, Archibald
*Hewlett, C. W.
Hickerson, T. F.
Hobbs, A. W.
Hoffman, S. W.
*Holmes, J. S.
Ives, J. D.
*a*Johnson, E. D.
Kilgore, B. W.
Lake, J. L.
*Lanneau, J. F.
*Lay, G. W.
Leiby, R. W.
Lewis, R. H.
Logan, C. C.
Lyon, Mary
*a*Marion, S. J.
*Mendenhall, Gertrude W.
Newman, C. L.
*Nowell, J. W.
*Patterson, A. H.
Pegram, W. H.
Pillsbury, J. P.
Poteat, W. L.
*a*Pratt, J. H.
*Randolph, E. O.
Randolph, Mrs. E. O.
Randolph, E. E.
Rankin, W. S.
Riddick, W. C.
Roberts, G. A.
*Robinson, Mary

Sherman, Franklin
*Seymour, Mary F.
Shore, C. A.
Spencer, H.
*Strong, Cora
*a*Totten, H. R.
Venable, F. P.
*Wheeler, A. S.
Williams, L. F.
Wilson, H. V.
*Wilson, R. N.
Withers, W. A.
Winters, R. Y.
*Wolf, F. A.
*Wolfe, J. J.

The following papers were then presented:

Some Methods and Results of a Plankton Investigation of Chesapeake Bay. J. J. WOLFE AND BERT CUNNINGHAM.

The material was collected by the U. S. Ship *Fishhawk* at definite areas in the bay between October, 1915, and September, 1916. The methods of collection, preservation, volume determination, and counting were discussed. In determining the volume, the centrifuge was used on an original collection of 250 cc. Organisms in 25 cc. were counted.

The following conclusions were drawn: (1) There is little or no relation between the volume of the precipitate and the number of organisms. (2) Volume increases with depth. (3) Great variations in number of organisms occur in surface collections made on the same day, probably due to tidal influences. (4) The maximum of organisms is found at about 27 meters. (5) The optimum temperature lies between 46 degrees and 55 degrees. (6) The number of organisms increases greatly in two annual crests—spring and fall. This is not due to a general increase of all species, but to very great increase in one.

Further Occurrence of Cross-Conjugation in Spirogyra. BERT CUNNINGHAM.

The writer reports the occurrence of cross-conjugation in *S. weberi* Keutz. This supplements a previous report of the occurrence in *S. inflata*.

Notes on Buds. E. W. GUDGER.

Descriptions were given of the buds of the Sycamore, Smilax, and Sumac; all of which are found, not in the axil of the leaf, but under the base of the leaf, and hence, when the leaf has fallen, *in* the leaf scar. Attention was called to the compound flower buds of the Dogwood, Norway Maple, and Azalea, and to the complex-compound or mixed buds of the Sassafras and the Sweetgum. These buds being terminal buds of woody plants, would check the growth of plants were not some method devised by the plant to prevent this. The Dogwood and Norway Maple have two opposite buds below the flower bud which develop into branches. The Azalea has a cluster of lateral buds just beneath the big terminal flower bud, and these grow out into a well-marked whorl. The Sassafras has in the center of its large terminal bud a very small leaf-stem bud, while the Sweetgum keeps up its excurrent growth by a lateral bud which develops below the flower cone and forms a new branch.

Entrance Requirements in Science at the State Normal College. E. W. GUDGER.

The entrance requirements at the State's College for Women have recently been rewritten, and an attempt made to standardize them. They are now as uniform as the subjects permit for all the sciences accepted for entrance. Another purpose in working them over has been to write them in sufficient detail to give the teachers of high school science in North Carolina some standards to work to and some definite idea of the absolute amount of time required for a unit and the relative proportion of laboratory and recitation time. In the biological sciences, for the write-up of which the author is responsible, emphasis has been laid on the outdoor side of natural history, and a fair number of field trips in some cases will be substituted for laboratory work.

For all the sciences, emphasis has been laid on how well the subject has been taught and studied, and not on the quantity of space covered, on the formation of habits of observation and inference, of concentration and clear thinking.

The following papers appear elsewhere in this issue of the JOURNAL OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY:

The Sun's Eclipse, June 8, 1918. Question. JOHN F. LANNEAU.
Extension of the Range of Prunus umbellata into North Carolina. J. S. HOLMES.
Eliminations from and Additions to the List of North Carolina Reptiles and Amphibians. C. S. BRIMLEY.
Herpetological Fauna of North Carolina Compared with that of Virginia. C. S. BRIMLEY.
Report of Investigations on the Cause of the Death of Matured Chicks in Shell in Artificial Incubation. H. B. ARBUCKLE.
A Visit to Smith Island (Lantern). W. C. COKER.

For the following papers no abstracts have been received:

The War Work of American Physicists. C. W. EDWARDS. (Read by the Secretary.)
Some Important but Largely Neglected Scientific Facts. GEORGE W. LAY.
Symptoms of Disease in Plants. F. A. WOLF.
Notes on the Magnetic Compass. T. F. HICKERSON.
Variations Within the Individual Sponge Towards Types of Structure Characteristic of Other Species and Genera. H. V. WILSON.
New or Interesting North Carolina Fungi. H. C. BEARDSLEE.
Mineral Fertilizers: Their Mode of Occurrence and Distribution in North Carolina. COLLIER COBB.
Recent Changes in Currituck Sound. COLLIER COBB.
The Return Stroke Due to Lightning. A. H. PATTERSON.
Azalea atlantica and variety. W. C. COKER.

E. W. GUDGER,
Secretary.

LUMINESCENCE OF ZIRCONS

By F. P. Venable

It has long been known that zircons from certain localities, as Norway and Expailly in France, phosphoresce when heated to low redness. Many of the zircons under this treatment become colorless and transparent, also in most cases the density is permanently increased. A number of investigations have been made into the cause and possible inter-relation of these phenomena.

Damour (Compt. Rand. **58**: 154) has shown that there is slight and often inappreciable loss of weight in heating; that the index of refraction is changed as well as the density and that the increased density remains unchanged even when the heating is pushed to fusion (except in one or two of the cases examined). He suggests that it may be a matter of allotropism, the action of heat bringing about the change into the second allotropic modification. Fizeau (Compt. Rend. **66**: 1005) has shown that heat causes a lasting expansion of form.

The density of zircons varies from 4.0-4.74. This may be due in part at least to the presence of impurities driven off in the heating and to small variations in composition such as are revealed in the large number of published analyses. Zircons with a density under 4.7 may be raised to that density on heating. Those with a density of 4.7 show no material change.

The luminescence in question appears according to Henneberg (J. prakt. Chem. **38**: 508) at a temperature lower than that at which the color is lost or changed. The loss of weight may be from practically nothing to 0.45% and the change of density from 2.5% to 1%. The brown red color is lost at a temperature of about 300° C. Spezia (Ber. deutsch. chem. Ges. **10**: 295) has stated that according to his experiments the change of color is due to the reduction of the ferric compounds present, and that heating in a stream of oxygen restores the color. The experiments of Hermann (Z. Anorg. Chem. **60**: 369) were more detailed and exhaustive and he agrees with Spezia that the color is largely due to iron in different stages of oxidation and in the case of green zircon to an admixture with chromium.

Still Doelter (Monatsh. Chem. **31:** 319) concludes from his own investigations that Spezia is wrong in assuming that iron confers the color and believes that it is due to a colloidal substance of unknown nature. With regard to density he finds the green zircon to have the lowest and the colorless to have the highest (4.74). Green and yellow-green zircon, he thinks have a different coloring matter from brown and red (hyacinths). Stevanovic (Z. Kryst. **37:** 247) states that the bi-axial green zircon (D. 4.3) changes on heating into the uniaxial normal with a density of 4.7.

The varying accounts as to the properties and behavior of zircons may be in part explained by the somewhat wide variations in the composition of this mineral coming from different localities and the neglect on the part of earlier investigators to exclude the infiltrations of foreign matter which necessarily vitiate their results. Due precaution was exercised by Doelter and other recent workers to remove as far as possible such material as did not form a component part of the crystals.

Further light has been thrown on these changes in zircons by a study of their radio activity and the action of radium emanations upon them.

The radio-activity of zircons is markedly greater than that of any other hard mineral occurring in igneous rocks. Further, zircons contain hundreds of times more helium than the average rock of which they are constituent parts, and Strutt (Proc. Roy. Soc. A. **78,** 152: A. **83,** 298: A, **89,** 405) has made use of this fact as a means of determining the geologic age of the surrounding rock. This radioactivity is in excess of the uranium or thorium contents and indicates the presence of an accumulation of radium. The uranium-lead ratio has been determined by Holmes, the percentage of uranium found being 0.0019, and of lead 0.000085 (Proc. Roy. Soc. A. **85,** 248). Zircons show a greater radio-activity, also, than any other mineral associated with monazite.

The fact that the only mineral known to contain argon is the zircon mineral, malacone, has also aroused comment, but not enough investigation for complete confirmation (Kitchin and Masterson, Lond.

Chem. Soc. **89**: 1568). On heating, the mineral gives off both helium and argon. Twenty per cent of the helium is accounted for by the uranium present. Antropoff (Z. Elektrochem. **14**: 585) claims to have secured argon on heating native zirconia (baddeleyite) from Brazil. These observations should be most carefully tested by further investigations, as they open far-reaching theoretical questions.

This radio-activity of zircons has produced in the enclosing biotite, iolite, etc., the usual pleochroitic halos observed in connection with other radio-active minerals.

Strutt, as cited, makes use of the radio-activity of zircons for determining the age of geologic formations. Zircon crystals in plutonic rocks are opaque, those in basalt and lavas are transparent and show signs of incipient fusion. The transparent crystals are thermo-luminescent, giving out a phosphorescent glow and losing color when moderately heated. This property of thermo-luminescence has been noted in a number of minerals, as certain fluorites, etc. The glow is not repeated on a second heating if once heated until it disappears. Strutt found that it can be restored, and also the color, by exposure to the action of radium salts. This alternation can be repeated apparently indefinitely. Fluorspars act in the same way. Of course it is well known that the silicates in ordinary glass containers of radium compounds are deeply colored after sufficient exposure. Opaque zircons are not thermo-luminescent nor made so by exposure to radium. Nor are they decolorized by moderate heating. If kept in melted basalt for twenty-four hours they become white though not transparent, and then on exposure to radium emanations they acquire a red-brown color like the hyacinth and are thermo-luminescent. This treatment, however, does not make them transparent.

It is stated by Demarcay (Compt. Rend. **104**: 113) that zircons lose their color when heated in a stream of carbon tetrachloride. Only imperfect success was obtained on subjecting opaque zircons to this treatment. They were practically whitened and some small splinters seemed to be transparent.

CHAPEL HILL, N. C.

THE SUN'S ECLIPSE JUNE 8, 1918: QUESTION

BY JOHN F. LANNEAU

Who in the shadow path on June 8th at the time of the total eclipse will look for

"A NEW ECLIPSE PHENOMENON"?

When the total eclipse of the sun on May 28, 1900, was seen at Wake Forest, N. C., a surprising thing was noted.

My account of it was given in *Popular Astronomy* for February, 1901, in an article headed "A New Eclipse Phenomenon."

Quoting from that article:

> A trivial addition to our outfit for the various observations made was a number of neatly prepared smoked glasses for naked-eye views of the progress of the eclipse.
>
> Each of these eye protectors consisted of a piece of clear glass, about six inches square, put over the smoked surface of a like piece of glass, the two held together securely by paper pasted along their edges. These simple glasses made an unexpected revelation.
>
> Soon after first contact, but more especially five or ten minutes before totality, when a smoked glass was held somewhat toward the sun, and tilting westward, there was seen on its nearer surface, as in a dull mirror, three fairly distinct bands extending horizontally across the glass. The bands were each about a quarter of an inch wide. The upper edge of each band was uneven or wavy. The lower part of each presented a ragged outline—a series of pendant tongues variously pointed and differing in length, breadth, and contour. Each band looked something like the familiar mirrored band of "manometric flames" produced by sound vibrations, only fainter, less regular, and also inverted, that is, the "tongues" downward.

I so described the phenomenon in 1900. It was noted just before totality. But, diverted by the coronal splendors, no one looked for "reflection bands" just *after* totality. Had they been seen *then,* I think the "tongues" would have been, not pendent, but erect—pointing *up*.

In previous eclipses, for many years, there had been observed the well known, but unexplained, "shadow bands"—alternate dark and bright bands which just before and just after totality flit along the ground and across the south walls of buildings.

These often-seen shadow bands and the reflection bands first seen at Wake Forest in 1900, have doubtless a common origin.

Recall some well-known facts. The moon's surface is excessively rugged. On the side which is always turned towards us there are more than thirty-three thousand mountains. Part of the very rim of the moon is outlined by long mountain ranges. The moon's shadow cone, when it reaches the earth—as it must to make a total eclipse of the sun—is about two hundred and forty thousand miles long. It tapers from its base at the moon, two thousand miles across, to a width, where it meets the earth, of never more than one hundred and sixty-eight miles. Sometimes, at the earth, the shadow is less than one mile wide.

The observer of totality must be in the comparatively small shadow spot.

My *theory* is that both sets of bands, the familiar "shadow bands" and the newly observed "reflection bands" are caused by furrows of light in the surface of the shadow cone—furrows constantly lessening as they converge to the point of the cone—grooves of light broad and deep at the cone's base around the moon's mountain-peaked, serrated rim, but quite small where the shadow cone reaches the earth near its point.

The eclipse of 1900 was in the morning. Just before totality we were in the *under* surface of the shadow cone—the ridges of shadow, between adjacent light grooves, hanging or pointing *down*.

The eclipse of June 8th will occur in the afternoon. Just before totality the observer will be in the *upper* surface of the shadow cone—the ridges of shadow pointing *up*. He may therefore expect that "reflection bands" seen then will have, not pendent tongues, but tongues *pointing up*.

But facts are wanted. On the 8th of June, who in the long line of observers—from Southbend in Washington on the Pacific Coast to Orlando in Florida on the Atlantic—will get the facts?

Who of them will prepare in advance smoked glasses, and will look for "reflection bands" just before totality and just after totality? And who will have in readiness a kodak to picture the bands across his smoked glass?

WAKE FOREST, N. C.

ALTERNATION AND PARTHENOGENESIS IN PADINA*

By James J. Wolfe

The species with which these experiments were carried on is very abundant at Beaufort, and is reported as common on the coasts of Florida and the West Indies. Algologists have very generally referred it to *Padina durvillaei* Bory, but early in the course of this work the writer became convinced that this reference was incorrect. Specimens were then submitted to Dr. Farlow of the Harvard Cryptogamic Laboratory for his opinion in the matter. After his usual thorough examination, the details of which are reserved for a later paper dealing with the general morphology of the species, Dr. Farlow writes that he regards the form as *P. variegata* (Kg.) Vickers (8 & 9). Furthermore, Dr. W. D. Hoyt states that Mr. F. S. Collins, who has worked on his collection of Beaufort algae likewise refers this form to *P. variegata*. It is therefore reasonably safe to conclude that the common species of our eastern shores and the one upon which these experiments are based is *P. variegata* (Kg.) Vickers.

This plant presents the interesting condition seen in Dictyota and many red algae of three individuals in one life cycle—male, female, and tetrasporic. On casual inspection the three are quite similar, but under the microscope, even though their vegetative cells are alike, they can be readily distinguished by their reproductive structures, at least in the great majority of cases. With practice one acquires considerable skill in distinguishing them with the hand lens and even with the unaided eye.

In 1904 Williams (7), working with *Dictyota dichotoma*, presented very fully and completely the cytological evidence for the alternation of the asexual or sporophytic generation with the sexual or gametophytic. Hoyt in 1910 (1) published a brief account of his cultures from fertilized eggs and tetraspores of *D. dichotoma*, showing, as was expected from the cytological evidence previously brought out, that without exception the fertilized eggs produce tetrasporic

*Contribution from the Laboratory of the Bureau of Fisheries, Beaufort, N. C. This paper, in somewhat shortened form, was read before a joint session of the Botanical Society of America and the Botanical Section of the A. A. A. S. at their 1918 meeting in Pittsburg.

plants and that tetraspores invariably produce male and female plants. Since the present experiments were begun, Lewis (2) has published the results of similar experiments upon several species of Rhodophyceae; his findings without exception confirming the theory of alternation.

Perhaps it may not be out of place in passing to point out that these plants, together with the one now under discussion, furnish teaching material peculiarly valuable in presenting the theory of antithetic alternation of generations by reason of the fact that the sporophyte is an entirely separate and distinct individual plant of equal size and the same general appearance as the gametophytes.

During the summer of 1910, while engaged at the Bureau of Fisheries' laboratory at Beaufort, N. C., in working on the morphology and cytology of Padina, it occurred to the writer that it would be well to duplicate Hoyt's work on Dictyota with this species. Furthermore, as it had been noticed that unfertilized eggs in laboratory cultures produce sporelings indistinguishable from those produced by tetraspores and fertilized eggs, and, as algologists (4) were uncertain as to whether or not fertilization was absolutely necessary in certain of the Dictyotaceae, it was determined to include unfertilized eggs in these experiments.

To grow spores to maturity at the laboratory being impossible, the method devised by Hoyt (1) was resorted to. Cultures were started in aquaria on oyster shells which were later transferred to various places in the harbor. The material to be used in these cultures when brought to the laboratory was sorted with the compound microscope, males being put into one aquarium, females into another, and tetrasporic plants into a third. They were kept thus under running water for variable periods of time before the experiments were begun. This was a precaution against transferring antherozoids in the experiments with unfertilized eggs, since, although there is a certain periodicity in the production of eggs and sperms and, as far as possible, material was therefore collected on the day preceding maturity of sexual elements, there are sometimes two or even three crops of antheridia on a plant at the same time. So far as sperms are concerned this precaution proved unnecessary, but very long periods of time (several days)

were of value in overcoming another serious difficulty—namely, the fact that fertilized eggs remain attached to the parent plant for many hours and perhaps days. This will be referred to later.

Selected individuals were then transferred to aquaria of sea-water which had been filtered in order to remove any chance reproductive bodies. Oyster shells previously scrubbed and dried were placed in the aquaria beneath the plants. Upon these the eggs and spores settled in great abundance and immediately germinated. This was found to be true of the eggs whether males had been put in with the females or not—a clear case, it would seem, of parthenogenetic germination. In every case there was a liberal growth of young plants before the shells were transferred to the sea. The cultures were kept in the laboratory for different periods of time, varying from four to twenty-four days, occasionally changing the filtered water upon them. Laboratory conditions within the above given time limits seemed to have had no adverse effect upon them except that growth was less rapid than when they were in natural surroundings.

Incidentally, measurements of length were made when these cultures were studied. The greatest length attained by any of the plants is given in a separate column in most of the tables. By comparison of the date on which the experiment was begun with the date of collection an approximate idea of the rate of growth may be gotten. In the first 50 days the best plants reach about 40 mm. in length, thus attaining something less than an average of a millimeter a day. In the next 30 days they frequently increase to 100 mm., thus averaging about 2 mm. per day. Approximate measurements made on selected plants growing normally on the rocks confirm this result.

A total of 63 such cultures were prepared and planted during this summer, 22 derived from tetrasporic plants, 22 from males and females, and 19 from female plants alone. In order to avoid contamination from chance spores these cultures were generally planted in regions at some distance from those in which Padina grew normally. Unfortunately, as was subsequently found, the conditions of growth are exacting, and consequently but few cultures matured their plants, and these in but small numbers. For the sake of brevity, and in view

of the fact that much fuller data were secured in subsequent years, a detailed report covering these cultures is omitted, as well as for the summer of 1911, in which the experiments were again begun, but terminated before completion except in very small part by the writer's unavoidable withdrawal from the laboratory.

TETRASPORES

During the summer of 1912 the experiments were again duplicated. For testing the product of tetrasporic plants, 4 series of 4 shells each were prepared in the manner above described. The cultures were planted between the 29th of July and the 9th of August. Since it had been found, as above mentioned, that little or no growth occurred except in places where Padina naturally thrived, cultures were planted in such localities exclusively. The shells were secured at different distances below the low-tide level to iron pipes driven into the sand. This was done with copper wire passed through holes drilled in the shells and pipes. As but little growth had occurred by the time it was necessary for the writer to leave the laboratory, a return trip to collect them was made September 25th. They were taken to Durham, N. C., in alcohol. By means of holes drilled in the shells and notches filed on the edges every culture could be identified with absolute certainty. Every plant from these cultures was examined with the compound microscope in order to determine with positiveness the kind of reproductive body borne upon it.

Of the 16 cultures covered with sporelings when planted, 5 showed no growth, 4 were not recovered, while the other 7 gave varying degrees of success. Table No. 1 gives the results and in part the conditions of the experiment all tabulated in detail. The total result is 154 males, 134 females, no tetrasporic, 2 doubtful, and 239 sterile individuals of small size. The doubtful plants are so classified because they have but few reproductive elements and these so young that it could not certainly be told whether they were female or tetrasporic. It should be stated, perhaps, that female and tetrasporic plants are, when young, often very similar in appearance, and in many cases even when mature can be distinguished with certainty only by measure-

ment. When mature the diameter of the tetraspore mother-cell is nearly twice that of the egg.

The relatively small number of plants which reached maturity in these cultures as compared with the much greater numbers secured in subsequent repetitions is believed to be due to lack of proper illumination resulting from the fact that the shells were so attached to their supports as to present their edges to the incident rays of light. Consequently, relatively few plants were favorably situated as regards sunlight. Especially is this worthy of consideration when one recalls that rays of light are refracted towards the normal on passing from air into water. Probably, also, some cultures were located on the north sides of their supports, and hence received no direct rays at all, as this detail had not then occurred to the writer. These ideas together with the further probability that the optimum depth which also appears to lie within narrow limits was not in all cases secured would, it would seem, account for the fact that no plants matured on 5 of the 16 shells, all of which were covered with sporelings when planted.

From the above seven successful cultures, however, it may be stated with certainty that tetraspores produce only sexual plants, since there were no tetrasporic individuals whatever produced.

Attention should, perhaps, also be called to the fact that each of these successful cultures was derived from a single tetrasporic plant, and that in every case both males and females were produced and in approximately equal numbers with the exception of culture 3b, which gave only 2 mature plants and these females. The small number in this and the other cases, it is believed, sufficiently accounts for the slight disparities. Comparison with the results obtained in 1914 and 1915, shown in Tables 4 and 8, where the numbers are larger, adds probability to this conclusion. These results indicate that sex is predetermined, probably when the spores are formed, and that one-half the spores bear the determiner for maleness and the other half for femaleness. This conclusion is rendered more probable when we recall that the spores producing male and female plants in equal numbers were derived from a single tetrasporic plant and grew upon

the same shell. It is difficult to think that the conditions here could be sufficiently different to have a determining effect upon sex. The view above expressed is of course in line with modern views of sex determination.

There remains to be discussed, perhaps, the fact that in Tables 4 and 8, which give the results of tetraspore cultures made in 1914 and 1915 respectively, tetrasporic plants occur—2 in 1914 and 20 in 1915. By reason of their location, now to be discussed, the chances for contamination by fertilized eggs floating to and settling upon the shells after they had been planted, were greater in 1914 than in 1912, and still greater in 1915. Since, as has already been pointed out, cultures were unsuccessful except where Padina normally occurred, it was absolutely necessary to locate them in the vicinity of other plants. In 1912 (Table 1) the shells were placed with their surfaces perpendicular to the surface of the water, which of course made the likelihood of chance spores lodging upon them very slight indeed, even though an abundance of plants bearing spores was nearby.

In 1914 (Table 4) the shells were attached to flat stones. The stones were then sunk some distance away from plants but in the general region of Padina growth and in such position that the surfaces of the shells bearing the cultures were parallel to the surface of the water. The better illumination would probably account for the greater number of plants reaching maturity per culture than in the former case. In 1915 (Table 8) the cultures were attached to stones as before and then placed in among growing Padina, merely removing the plants touching the cultures and those immediately around, their abundance rendering it impracticable to do more on account of the physical labor involved. The chances of contamination being thus vastly greater, it is not surprising to find a larger number of intruders. The facts above recited sufficiently explain, it is believed, the absence of tetrasporic individuals in 1912, the presence of 2 in 1914, and 20 in 1915.

Perhaps it should be added here that these experiments were attempted also in 1913, but the supports to which they were attached were undermined and washed away by a severe storm which swept the

southeastern Atlantic coast on the evening of September 2, 1913. Only a few cultures were recovered and these somewhat mutilated. As they show nothing that is not shown in the more complete series, a report here is not deemed worth while.

Considering now only those cultures which were successful and omitting such as failed entirely because such failure was in all probability due to the conditions of the experiment, the results from Tables 1, 4, and 8 may be summarized as follows:

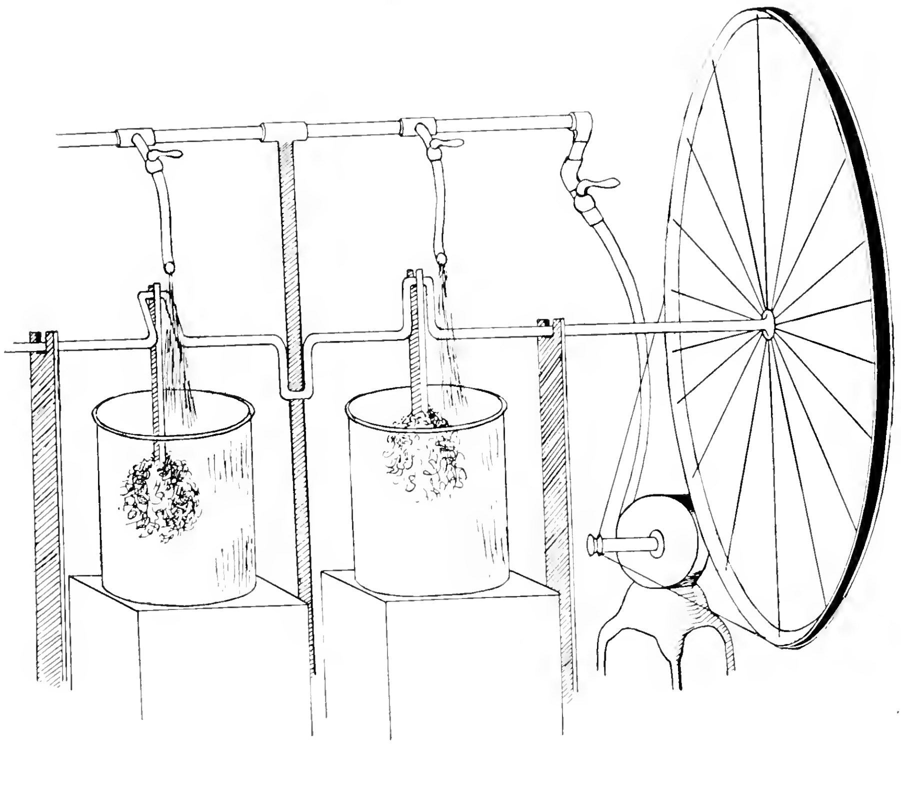
Date	Number of Successful Cultures	♂	♀	⊕	Average Number of Plants Per Shell
1912	7	154	134	0	41+
1914	8	242	257	2	62+
1915	8	426	379	20	103+
Totals	23	822	770	22	
Average per culture		35+	33+	0.9+	70+
Percentage of error				.01+	

The writer thinks that the tetrasporic plants already discussed can now safely be disregarded, and that there is nothing in the entire series which in any way weakens the statement based upon the 1912 cultures—that tetraspores produce only male and female plants, and these in equal numbers, even when the spores are from a single parent plant, as well as the seemingly necessary deduction that sex is predetermined, probably in the reduction division of the tetraspore mother cell.

FERTILIZED EGGS

The experiments to test the product of fertilized eggs as first devised were baffling in the extreme (see Tables 2 and 5). These tables are labeled "Cultures derived from Male and Female Plants" because it is believed, as will appear in the discussion to follow, that little or no fertilization occurred. The shells and plants were treated as in the experiments with tetrasporic plants. Four series of 4 shells each were carried through in 1912. For each series one male and one

PLATE 1



EXPERIMENTAL APPARATUS

female plant were put in each aquarium except series 5, in which several males and females were used. Of the 16 cultures thus obtained from male and female plants placed together in the same aquarium, which it was for a while supposed certainly insured fertilization, 5 only exhibited a tolerable growth. Fourteen of these plants are females, 2 males, 14 tetrasporic, 3 doubtful, and 97 sterile. We should expect only tetrasporic individuals, and we should expect also much larger numbers, comparable to some extent with those secured when tetrasporic plants were used as the source of the cultures. The results are not markedly different from those obtained when female plants without males were used as the source of the spores (Table 3).

The experiment was duplicated again in 1914 (Table 5) with essentially the same result, except that a greater proportion of cultures were successful and the number of plants per culture was somewhat larger. Since the opportunity for foreign spores to settle upon the cultures was somewhat greater by reason of the fact that the shells were attached in the immediate vicinity of fruiting plants, with their surfaces in the horizontal instead of the perpendicular, it is now safe to conclude, especially in the light of the following experiment, that most of these plants were derived from chance reproductive bodies settling upon the shells rather than the supposedly fertilized eggs which were germinating upon them when planted. It had previously been supposed that sperms would be freely discharged in the quiet water of aquaria as are the eggs and tetraspores. An examination, however, of the water in which male plants had been kept one night showed the presence of but few sperms. It was then concluded that the lacking factor for the discharge of sperms was probably the constant activity of the sea in localities where Padina grew successfully.

Accordingly, in the summer of 1915 two series of experiments were devised to test this idea. The plants, male and female, were tied to supports so attached to an axle that they were alternately forced down into the water and elevated a few inches above at each revolution (Plate 1).

The device was driven by a small water motor. In other respects the conditions were the same as in the experiments previously described. The results are shown in Table No. 11. From the 8 cultures 40 male, 33 female, and 776 tetrasporic plants were obtained. The 40 males and 33 females, representing a little more than 8% of the entire growth, are not too numerous, it is thought, to be accounted for as intruders, since the cultures were located in the midst of fruiting plants. This experiment, therefore, fairly conclusively demonstrates that only tetrasporic plants are produced by fertilized eggs.

PARTHENOGENESIS

As has been said above, it was noticed early in this work that unfertilized eggs germinated freely. It was assumed that these young plants would grow to maturity, but what they would produce was in doubt. From the uncertainty in the writings of algologists as to whether or not the sperms in the Dictyotaceae (4) are functional, it was of course permissable to expect tetrasporic plants. On the other hand, since it has been shown in the preceding experiments that tetraspores invariably produce males and females, and that fertilized eggs produce tetrasporic plants, as well as from analogy with other algae (7), it must be assumed that the chromosome number is reduced in spore formation and hence female plants and eggs must of necessity contain the haploid number. It is difficult to see how the diploid number characteristic of the tetrasporic plant (7) could be restored. The writer inclines to the view already expressed that the sex of the gametophytes is determined in the reduction division of the spore-mother-cell. Therefore it would be logical for germinating unfertilized eggs if they mature at all to produce female plants.

These alternative views will now be discussed in connection with the experiments. In 1912, 4 series of 4 shells each (see Table 3) were carried through. Although they were all covered with germinating eggs when planted, only 3 gave mature plants when collected. The cultures derived from female plants without males were strung on the same wire with those from tetrasporic plants as well as with those from both male and female plants, all on the same support.

Since 7 cultures of tetraspores were successful, whereas only 3 from unfertilized eggs gave mature plants, the conditions being identical, it must be assumed that the failure to produce mature plants on the part of at least 4 cultures of unfertilized eggs can only be explained by assuming that they were incapable of doing so. The few plants which were produced are probably due to chance spores falling into depressions on the shells, even though they were placed on edge, except perhaps some of the tetrasporic individuals—these latter to be referred to later.

In 1914 and 1915 control experiments were carried through in order to see the relation between the plants produced by spores which simply chanced to fall from Padina in the vicinity of the cultures. These controls were simply cleaned oyster shells, without reproductive elements of any kind upon them, attached alongside and therefore exposed to the same conditions as those bearing sporelings. The results are given in Tables 7 and 10. It will be noticed that male plants are most numerous, females less so, and tetrasporic least of all. It might be assumed that they should be equally numerous, as they are apparently so in nature. An examination of the various cultures will show that females are larger before beginning to fruit than males, and that tetrasporic plants are usually still larger, generally, than either males or females. Table 11, for example, shows but 2 females fruiting below 20 millimeters in length, whereas 6 males of this size are thus found. This relation, however, is not evident in all cases, and in particular cultures it is even sometimes reversed, but a careful calculation based on a large number of individuals bears it out. In Table 8, for instance, there are only 66 females fruiting below, to 313 above, 20 mm. in size. If the ratio for males, 89 to 337, should have been maintained, we should have had 83 instead of 66. In all the tables relatively few fruiting tetrasporic plants are found below 20 mm. in length. This difference in size at which the different plants produce reproductive bodies is believed to account for the slight preponderance in numbers of males over females, and both over tetrasporic individuals. In other words, there are among the young sterile individuals enough female and

tetrasporic plants, not sufficiently mature to produce reproductive bodies and hence indistinguishable, to bring their numbers to a parity with the males in the control cultures for 1914 and 1915. Examination of the various tables will show that sterile plants are all relatively small in size. During the entire course of these experiments very few were found as much as 30 mm. in length. This is true, however, only late in the season. When the plants first appear, late in June at Beaufort, they seem never to fruit until quite large, 60 to 100 mm. in length.

When the cultures from unfertilized eggs (Tables 3, 6, and 9) are compared with the controls, the only noteworthy difference is the greater number of tetrasporic plants found. Compare the following summaries:

CONTROL CULTURES

Date	Number of Successful Cultures	♂	♀	⊕	Average Number of Plants Per Culture
1914	6	66	47	34	24+
1915	4	150	111	36	74+
Totals	10	216	158	70	------------
Average per culture	------------	21+	15+	7	44+

UNFERTILIZED EGGS

Date	Number of Successful Cultures	♂	♀	⊕	Average Number of Plants Per Culture
1912	3	1	20	24	15
1914	19	190	142	166	26+
1915	8	142	93	244	59+
Totals	30	333	255	434	------------
Average per culture	------------	11+	8+	14+	34+

Whence comes this excess of tetrasporic plants in the cultures from unfertilized eggs as compared with the controls. The writer thinks that they are unquestionably due to eggs which were fertilized pre-

viously to being shed. Table 6 would seem to show this. In this case the same individuals used in series 3 were also used as a source of eggs for series 9, 10, 11, and 13. In series 3, where the plants had been kept separate from males for only 6 hours, we get males 11, females 9, tetrasporic 30—that is, tetrasporic individuals are greatly in excess; whereas in series 9 we get males 59, females 61, tetrasporic 51. Here the female plants were separated from the males for 13 days. This gave sufficient time for the fertilized eggs attached to the source plants to drop off before the experiment was begun. So with series 10, where they had been kept 18 days. This procedure was rendered possible after it was discovered that plants kept in the laboratory, and well aerated by a method devised by Mast (5), would continue for several weeks to produce eggs, so that the same plants could be used as a source of eggs for quite a long time. Individual cultures even in this table and some subsequent ones show variations from this average which it is believed are sufficiently accounted for by their location in the vicinity of other plants.

Series 3 of Table 9 gives as a whole males 71, females 37, and tetrasporic 23, a result entirely in line with the control cultures, and is sufficient to show that unfertilized eggs are incapable of reproducing Padina in any one of its three forms, since the results produced are clearly comparable to those secured in the controls.

However, Series 6 of the same table gives males 71, females 56, and tetrasporic 221. The great excess of tetrasporic plants in every single culture of this series can be due only to previous fertilization. Since the plants were here kept separate only two hours, it is highly probable that a greater number of perviously fertilized eggs were still attached to the parent plants when the experiments were begun. As this difficulty has entered into so many of the experiments a brief test of it was made in 1916. Female plants after having been kept separate from males for 24 hours were allowed to discharge their spores in the usual manner. The plants were then attached to the device already referred to (text fig. 1) for the purpose of dislodging any fertilized eggs wihch might still be clinging to the parent plants. They were then moderately agitated for about one hour once or twice

each day for 5 or 6 days. By this time an entirely new crop of eggs had formed and were ready for discharge. They were collected upon slides and shells as before. The spores germinated abundantly in each case, but from the second lot none survived longer than two weeks, while there were a goodly number of sporelings 5 to 10 mm. long upon the first lot of shells when the experiment was discontinued about six weeks later. The latter are clearly fertilized eggs capable of growth into tetrasporic plants under normal conditions, while the former were unfertilized eggs which divided and formed a cell body consisting of as many as 50 cells in some cases, but all of which without exception eventually perished.

This rather remarkable power of the fertilized eggs to cling to the parent plants, probably within the oogonia, for such long periods proved a very confusing fact through all the experiments dealing with eggs.

Tables 2 and 5, giving the results when the cultures are obtained from male and female plants placed together in an aquarium in quiet water show essentially the same results as the unfertilized eggs and control cultures, except that the proportion of tetrasporic plants is a trifle greater than in either of the other cases, due in all probability to the occasional fertilization of eggs by the very few sperms liberated under these conditions. The plants found on these shells, then, with the exception of the excess of tetrasporic plants, are also the result of chance spores. The following summary may be compared with those given for unfertilized eggs and controls.

CULTURES DERIVED FROM ♂ AND ♀ PLANTS

Date	Number of Successful Cultures	♂	♀	⊕	Average Number of Plants Per Culture
1912	5	2	14	14	6
1914	7	60	55	100	30+
Totals	12	62	69	114	------------
Average per culture	------------	5+	5+	9+	20+

The term parthenogenesis as ordinarly understood implies the production of mature individuals from unfertilized eggs. For the purpose of clear thinking it would, therefore, seem to be necessary to separate the structures usually called eggs into two groups: (1) those in which there is the haploid number of chromosomes, (2) those in which the diploid number obtains. There is a considerable number of forms both in the animal and the plant kingdom in which a so-called parthenogenesis seems to be a more or less normal or natural process. But so far as the writer has been able to ascertain, even after diligent search, there is not a single clearly demonstrated case of natural parthenogenesis among these in which the parthenogenetic egg unmistakably presents the haploid or reduced number of chromosomes. In the case of the honey-bee the male is produced parthenogenetically from an egg apparently having the haploid number of chromosomes. However, maturation is here very abnormal. For example, no chromatin is thrown out of the egg in polar body formation, although it is separated from the female pronucleus. The fate of this chromatin is, furthermore, variously interpreted. With such evidence before us, it would seem that for the present at least we are warranted in refusing to consider this case as sufficiently well demonstrated to be counted an exception to the general statement made above. (See Hegner: "Germ Cell Cycle in Animals," p. 265.) In the cases, then, of so-called parthenogenesis the structures involved are not true eggs and therefore should perhaps receive a name which more accurately defines them. However, it is with eggs having the reduced number of chromosomes that artificial parthenogenesis concerns itself. Loeb and a number of other experimentalists have succeeded in initiating cell division in several different animal and plant (Overton (6)) eggs which presumably had the reduced number and were apparently incapable of dividing normally. The methods employed consist in subjecting these eggs to various mechanical and chemical treatments. They have thus been able to carry them from a few divisions to highly developed and apparently normal larvæ in the case of the frog to a stage in which the tail had practically been absorbed and 2 to 4 legs developed. Loeb and Bancroft

(3, p. 275) report the presence of distinguishable reproductive organs. However, in no single case has any such parthenogenetically produced animal been brought to sexual maturity.

It is rather too complacently assumed that the production of such mature animals is merely dependent upon the difficulty of imitating conditions in nature. These remarks are not intended to detract from the real achievement of these experimentalists who have demonstrated various methods of stimulating an egg normally incapable of division into further growth. Undoubtedly much light has been thrown upon the physics and chemistry of cleavage; nevertheless, the present purpose is to point out clearly that, in so far as is now demonstrated, this, instead of being parthenogenesis in the usual sense, is rather the artificial inauguration of a series of divisions of variable length in cells (eggs) generally incapable of further division, which may result in the production of more or less highly developed monsters, but which, as the experiments now being described indicate, are utterly incapable of reaching maturity.

Padina would seem to be an unusually favorable plant in which to test the potentialities of eggs germinating parthenogenetically, since the three individuals included in the life cycle represent both the haploid and the diploid chromosome numbers, reasoning from the behavior of tetraspores and fertilized eggs, and from analogy with Dictyota. Since it is difficult to see how the diploid chromosome number of the sporophyte is to be secured without fusion with the sperm, it might be supposed that eggs germinating with the haploid number could at least duplicate the gametophyte. The experiments above described have, however, shown this, also, not to be the case. The assertion of parthenogenetic germination in *Padina*, then, is nothing more nor less than the statement that the eggs are capable of a series of cell divisions. It is a fact that the shells were well covered when planted with eggs in division ranging from 1 or 2 cells to apparently well developed young plants. These had all the appearance of normal sporelings, attaching themselves to the shell, putting out rhizoidal filaments, etc. Nevertheless, somewhere between this time and the collection of the cultures they certainly per-

ished. The test made in 1916, already referred to, corroborates the result of the cultures. The first lot of eggs from the female plants gave sporelings which continued to develop during the course of the experiment. These, as has been said, were manifestly fertilized eggs, which remain attached to the parent plants for a remarkably long time, since the next lot, obtained about one week later and after agitating the plants sufficiently to dislodge the retained eggs, began growing as before, but all disintegrated after dividing into cells varying in number from 2 to as many as 50 or more.

Now, although in Padina and the Dictyotaceae generally unfertilized eggs germinate, according to the writer's interpretation of the above described experiments, in *Padina* at any rate, such germinating eggs invariably perish before reaching maturity. Comparing this case with the many cases of artificial parthenogenesis, it is unlikely that there can be any real differences between such cell division when inaugurated naturally and when artificially induced. If the former fail to mature, it would seem quitely probable that the latter must likewise fail, and from the same inherent difficulties, and therefore before artificial parthenogenesis is accepted in the sense in which it is ordinarily understood, it will be necessary to rear mature individuals from eggs containing the reduced number of chromosomes.

SUMMARY

The results above given in detail may be very briefly summarized as follows:

(1) Tetraspores produce only male and female plants. The numbers are approximately equal even when the spores are from the same plant and grown on the same shell. Sex is therefore predetermined, probably, in the reduction division of the tetraspore mother cell.

(2) Eggs when fertilized produce tetrasporic plants only. There is thus an alternation of a sporophyte generation which is an entirely distinct individual, with the gametophytic generation consisting of two separate plants, the one bearing eggs the other sperms.

(3) Unfertilized eggs divide freely, producing a cell body of varying size, but which invariably fails to mature. There is thus in *Padina* parthenogenetic germination, but no parthenogenetic reproduction.

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TABLE No. 1

TETRASPORIC CULTURES, 1912

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date Col-	♂	♀	⊕	Sterile	Doubtful
III..........	5 P. M., 7-8-12	14 hours	7-19-12	7-29-12	1 ⊕	3a	9-25-12	27	6	....	26	2
						3b	9-25-12	....	2	....	10	....
						3c	9-25-12	6	3	....	....	....
						3d	9-25-12	Not reco vered				
Totals........							....	33	11	....	....	....
VI..........	7-25-12	9 hours	7-25-12	8-1-12	Several ⊕'s	6a	9-25-12	....	....	....	....	....
						6b	9-25-12	....	....	....	....	....
						6c	9-25-12	....	....	....	....	....
						6d	9-25-12	Not reco vered				
Totals........								....	....	....	....	....
IX..........	7-28-12	7 hours	7-28-12	8-3-12	1 ⊕	9a	9-25-12	16	11	....	116	....
						9b	9-25-12	....	....	....	28	....
						9c	9-25-12	....	....	....	....	....
						9d	9-25-12	Not reco vered				
Totals........							....	16	11	....	....	....
XII..........	7-28-12	7 hours	7-28-12	8-9-12	1 ⊕	12a	9-25-12	94	97	....	54	....
						12b	9-25-12	11	15	....	5	....
						12c	9-25-12	....	....	....	....	....
						12d	9-25-12	Not rec overed				
Totals........							....	105	112	....	59	....
Grand totals........							....	154	134	0	....	....

TABLE No. 2

CULTURES DERIVED FROM ♂ AND ♀ PLANTS, 1912

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date Col-	♂	♀	⊕	Sterile	Doubtful
II	5 P. M., 7-18-12	11 hours	7-19-12	7-29-12	1 ♂ and 1 ♀	2a	9-25-12				3	
						2b	9-25-12		1	2		
						2c	9-25-12					
						2d	9-25-12					
Totals									1	2		
V	11 A. M., 7-25-12	9 hours	7-25-12	8-1-12	Several ♂'s and ♀'s	5a	9-25-12					
						5b	9-25-12					
						5c	9-25-12					
						5d	9-25-12					
Totals												
VIII	2 P. M., 7-28-12	7 hours	7-28-12	8-3-12	1 ♂ and 1 ♀	8a	9-25-12	2			6	
						8b	9-25-12					
						8c	9-25-12					
						8d	9-25-12					
Totals								2				
XI	2 P. M., 7-28-12	7 hours	7-28-12	8-9-12	1 ♂ and 1 ♀	11a	9-25-12		4	3	22	
						11b	9-25-12		9	9	66	3
						11c	9-25-12					
						11d	9-25-12					
Totals									13	12		
Grand totals								2	14	14		

TABLE No. 3

UNFERTILIZED EGG CULTURES, 1912

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂	♀	⊕	Sterile	Doubtful
I	5 P. M., 7-18-12	14 hours	10 A. M., 7-19-12	7-29-12	Several ♀'s							
						1a	9-25-12					
						1b	9-25-12					
						1c	9-25-12					
						1d	9-25-12					
Totals												
IV	11 A.M., 7-25-12	9 hours	10:50 P.M., 7-25-12	8-1-12	Several ♀'s							
						4a	9-25-12		3	1	10	
						4b	9-25-12					
						4c	9-25-12					
						4d	9-25-12					
Totals									3	1		
VII	2 P. M., 7-25-12	7 hours	11 P. M., 7-28-12	8-3-12	1 ♀	7a	9-25-12					
						7b	9-25-12					
						7c	9-25-12					
						7d	9-25-12					
Totals												
X	2 P. M., 7-28-12	7 hours	11 P. M., 7-28-12	8-9-12	1 ♀	10a	9-25-12		9	5	117	
						10b	9-25-12	1	8	18	30	2
						10c	9-25-12					
						10d	9-25-12					
Totals								1	17	23		
Grand totals								1	20	24		

TABLE No. 4

TETRASPORE CULTURES, 1914

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
I	12 M., 7-20-14	6 hrs.	10 P. M., 7-20-14	7-31-14	1 ⊕ Plant																			
Remarks: Good culture all over shell but left too long						1a	10-17-14	13		13	8		8										4	110
Good culture covering shell						1b	9-19-14	49	32	81	62	17	79					42					5	60
Shell covered by sand and culture nearly killed. Young all killed						1c	9-19-14	8		8	7		7											70
Plants confined chiefly to one end and edge of shell						1d	9-20-14	12	18	30	6	8	14	2		2	3	22			14		3	40
Totals										132			107			2								
V	10 A. M., 7-31-14	20 hrs.	10 A. M., 8-1-14	8-6-14	1 ⊕ Plant																			
Remarks: Good culture covering shell						5a	10-17-14	11		11	11		11										6	90
Little or no growth						5b	10-17-14																	
Good growth						5c	9-18-14	41	45	86	50	45	95					25						40
Culture covering shell						5d	9-19-14	60	85	145	60	91	151											40
Totals										242			257											
Grand totals										374			364			2								

TABLE No. 5

CULTURES DERIVED FROM ♂ AND ♀ PLANTS, 1914

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Total	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
II	12 M., 7-20-14	6 hrs.	10 P. M., 7-20-14	7-31-14	Several ♀ and 1 ♂ Plants																				
Remarks: Shell well covered						2a	10-17-14	4		4	8		8	40	4	44		6		2	2		1	5	100
Shell fairly well covered						2b	9-18-14	6	1	7	2	1	3	2		2	16	42	58			4	10	12	40
Scant growth and small						2c	9-18-14	2	11	13	2	3	5				3	41	47			5	7		40
Scant growth and small						2d	10-17-14	3	3	6	3	5	8	6	15	21						3	5	5	40
Totals										30			24			67									
VI	10 A. M., 7-31-14	20 hrs.	10 A. M., 8-1-14	8-6-14	1 ♀ and 1 ♂																				
Remarks: Somewhat scattered over shell						6a	10-17-14	6		6	1		1	18	1	19	5	2	7				1	12	70
						6b	9-19-14	3	8	11	6	5	11	7		7	2	34	36					4	35
No growth						6c	10-17-14																		
Scattered rather uniformly over shell						6d	9-20-14	3	10	13	6	13	19	6	1	7									
Totals										30			31			33									
Grand totals										60			55			100									

TABLE No. 6

UNFERTILIZED EGG CULTURES, 1914

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Total	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
III	12 M., 7-20-14	6 hrs.	10 P. M., 7-20-14	7-31-14	Several ♀ Plants																				
Remarks: Good growth over entire shell						3a	10-17-14	1		1	2		2	29	1	30	7	11	18					5	70
Fair growth only						3b	9-18-14	1	8	9	1	4	5					51	51			3	2	10	35
Scattered on edges of shell						3c	9-19-14	3	1	4	2		2				1	7	8				1		30
No growth, culture sanded up						3d	9-19-14																		
Totals										14			9			30									
IX		13 days	8-3-14	8-6-14	Same as in III																				
Remarks: Shell well covered						9a	9-19-14	10	34	44	15	21	36	7	3	10	9	84	93					9	40
Shell not well covered						9b	10-17-14		1	1	6	4	10	2	5	7	1	25	26					4	50
Shell well covered						9c	10-17-14	5	1	6	9	1	10	32	2	31	1	21	22	2			5	14	90
Shell not well covered						9d	9-18-14	1	7	8	1	4	5	1	42							4	1	6	30
Totals										59			61			51									

X	18 days	12 M., 8-9-14	8-11-14 *																		
Remarks	Plants confined chiefly to shell margins	10a	9-18-14	8	11	19	3	2	5				4	37				6	1		30
	Plants scattered	10b	9-19-14	3	18	21	4	4	8				2	93				7	3		30
	Plants scattered	10c	9-19-14	14	33	47	9	16	25	2	2	4	3	63				5	3	2	30
	Plants confined chiefly to one end of shell	10d	9-19-14	3	6	9	3	12	15	7	5	12	2	39				2	2	6	35
	Totals					96			53			16									
XI	20 days	10 P. M., 8-11-14	†																		
Remarks	Plants confined largely to one side and end	11a	10-17-14	3		3	2		2	23	4	27	1	8		3		1	21	14	60
	Plants confined largely to one spot on shell	11b	9-20-14											16				2	1		20
	Shell not recovered	11c																			
	Shell not recovered	11d																			
	Totals					3			2			27									
XIII	31 days	8-22-14	8-24-14 ‡																		
Remarks	No growth	13a	10-17-14																		
	No growth	13b	10-17-14																		
	No growth	13c	10-17-14																		
	Shell not recovered	13d																			
	Totals																				

*Same individuals as used in III and IX.

†Same individuals used in experiments III, IX and X.

‡Same individuals used in experiments III, IX, X and XI.

TABLE No. 6—CONTINUED

UNFERTILIZED EGG CULTURES, 1914

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Length Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Length Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Length Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Length Total	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
VII	10 A. M., 7-31-14	20 hrs.	10 A. M., 8-1-14	8-6-14	1 ♀ Plant																				
Remarks	Good growth on entire shell					7a	10-17-14	9	1	10	10	----	10	18	1	19	2	5	7	1	----	----	----	10	90
	No growth					7b	10-17-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Scanty growth					7c	9-19-14	----	----	----	----	----	----	----	1	1	----	3	3	----	----	----	----	----	20
	Scanty growth					7d	9-20-14	----	4	4	1	----	1	3	32	35	----	----	----	----	----	----	----	1	30
	Totals					----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
XII		10 days	10 P. M., 8-11-14	8-17-14	**																				
Remarks	Fairly good growth, though somewhat scattered					12a	10-17-14	1	2	3	1	1	2	19	2	21	----	15	----	----	----	----	----	6	70
	21 plants 15-20 mm. long, all sterile					12b	9-20-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20
	Shell not recovered					12c	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Shell not recovered					12d	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Totals					----	----	----	----	3	----	----	2	----	----	21	----	----	----	----	----	----	----	----	----

XIV ---- 21 days 8-22-14 8-24-14 ††																				
Remarks: No growth	14a	10-17-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Fair growth, but small	14b	10-17-14	1	----	1	4	2	6	1	----	1	13	82	----	2	----	----	----	19	40
No growth	14c	10-17-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Shell not recovered	14d	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Totals	----	----	----	----	1	----	----	6	----	----	1	----	----	----	----	----	----	----	----	----
Grand totals	----	----	----	----	190	----	----	142	----	----	166	----	----	----	----	----	----	----	----	----

**Same individual used in experiment VII.

††Same individual used in experiments VII and XII.

TABLE No. 7

CONTROL CULTURES, 1914

Series Number	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Total	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
IV	7-31-14	Surrounding Plants																				
Remarks: Plants confined to end of shell			4a	9-18-14	4	20	24	4	18	22	1		1	1	21						1	40
Shell uniformly covered			4b	10-17-14	12	1	13	7	2	9	9	1	10								7	100
			4c	9-19-14	8	6	14		4	4	2	1	3	4	25			1	5	6	6	40
Younger plants were sanded up and killed			4d	9-19-14	4		4	1		1	1		1	1		1			1		3	40
Totals							55			36			15									
VIII	8-6-15	Surrounding Plants																				
Remarks: Shell uniformly covered			8a	10-17-14	8	1	9	10		10	19		19	1	13				3	8	10	70
Plants scattered over shell			8b	9-18-14		2	2		1	1				2	26				1		3	30
Shell not recovered			8c																			
No growth			8d	9-18-14																		
Totals							11			11			19									

XV ..... 8-24-14 Surrounding Plants

Remarks

No growth	15a	9-18-14																		
No growth	15b	10-17-14																		
Shell not recovered	15c																			
Shell not recovered	15d																			
Totals																				
Grand totals					66			47			34									

TABLE No. 8

TETRASPORE CULTURES, 1915

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Total	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
I	10 A. M., 8-3-15	8 hrs.	10 P. M., 8-3-15	8-11-15	Several ⊕ Plants																				
Remarks: Good growth						Shell No. 1a	9-27-15	70	23	93	67	19	86	7		7	15	25	40			2	3		60
Good uniform growth						Shell No. 1b	9-27-15	70	28	98	45	17	62				5	20	25						50
Good growth						Shell No. 1c	9-27-15	60	15	75	55	9	64	3		3	12	25	37						50
Uniform growth, but small						Shell No. 1d	9-27-15	9	2	11	9	1	10				30	20	50						40
Totals										277			222			10									
IV	10 A. M., 8-17-15	8 hrs.	10 P. M., 8-17-15	8-24-15	Several ⊕ Plants																				
Remarks: Shell well covered—large plants						Shell No. 4a	10-23-15	25	11	36	21	17	38	1		1		3	3						65
Large plants—one corner bare						Shell No. 4b	10-23-15	26		26	28		28												75
Vigorous growth—uniform						Shell No. 4c	10-23-15	25	10	35	35	3	38	5	2	7	1	5	6				1		60
Excellent—uniform growth						Shell No. 4d	10-23-15	52		52	53		53	2		2	2		2						60
Total										149			157			10									
Grand totals										426			379			20									

TABLE No. 9

UNFERTILIZED EGG CULTURES, 1915

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Remarks	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Total	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
III	10 A. M., 8-3-15	8 hrs.	10 P. M., 8-3-15	8-11-15	Several ♀'s																					
						Shell well covered	Shell No. 3a	10-23-15	21	8	29	11	5	16	9	1	10	8	37	45			5	2	3	60
						Shell uniform—males well developed	Shell No. 3b	9-27-15	27		27	10		10	7		7	36		36			2	2	10	50
						Scattered growth	Shell No. 3c	9-27-15	7	7	14	6	5	11	5	1	6	1	20	21						55
						Scattered sparse growth	Shell No. 3d	9-27-15	1		1							5	19	24					3	30
						Totals					71			37			23									
VI	10 A. M., 8-17-15	2 hrs.	10 P. M., 8-17-15	8-24-15	Several ♀'s																					
							Shell No. 6a	10-23-15	30	5	35	17	6	23	49	2	51	17	16	33			2			50
						Uniform growth	Shell No. 6b	10-23-15	11	3	14	11	2	13	62	13	75	5	20	25						65
						Medium growth, but uniform	Shell No. 6c	10-23-15	9	3	12	5	2	7	42	10	52	1	20	21			3	1		60
						Fairly uniform	Shell No. 6d	10-23-15	10		10	12	1	13	39	4	43	5	15	20			1			70
						Totals					71			56			221									
						Grand totals					142			93			244									

TABLE No. 10

CONTROL CULTURES, 1915

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Length Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Length Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Length Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Length Total	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
VII	----	----	----	----	Surrounding Plants																				
Remarks: Scattered growth						Shell No. 7a	10-23-15	45	10	55	30	22	52	3	----	3	5	10	15	----	----	----	2	----	60
Fairly uniform						Shell No. 7b	10-23-15	44	----	44	16	----	16	23	----	23	13	----	13	----	----	5	28	----	50
Practically no growth						Shell No. 7c	10-23-15	----	----	----	----	----	----	----	----	----	----	14	14	----	----	----	----	----	15
Shell well covered—plants older at one end						Shell No. 7d	10-23-15	30	21	51	15	28	43	6	4	10	----	5	5	----	----	5	1	----	60
Totals						----	----	----	----	150	----	----	111	----	----	36	----	----	----	----	----	----	----	----	----

TABLE No. 11

FERTILIZED EGG CULTURES, 1915

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Total	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
II	10 A. M., 8-3-15	8 hrs.	10 P. M., 8-3-15	8-11-15	Several ♂'s and ♀'s																				
Remarks: Fairly good growth—uniform						2a	9-28-15	7	1	8	2		2	59	8	67	21	42	63						45
Shell well covered						2b	10-23-15	7	1	8	2		2	189	30	219	20	107	127			3	2		70
Good uniform growth, but small						2c	9-27-15	1		1	1		1	4		4	40	45	85						40
Good growth						2d	9-27-15	4		4	8	1	9	125	11	136	23	25	48						50
Totals										21			14			426									
V	10 A. M., 8-17-15	8 hrs.	10 P. M., 8-17-15	8-21-15	Several ♂'s and ♀'s																				
Remarks: Uniform over shell—fair cultures						5a	10-23-15	5		5	2		2	64		64	20	5	25			1	1		50
Uniform—excellent growth						5b	10-23-15	5	1	6	6		6	80	12	92	7	20	27				1		50
Uniform—good growth						5c	10-23-15	2	1	3	3		3	100	10	110	20	20	40				1		60
Uniform—good culture—large plants						5d	10-23-15	3	2	5	7	1	8	75	9	84		12	12						70
Totals										19			19			350									
Grand totals										40			33			776									

THE AMERICAN PITCHER-PLANTS

By Roland M. Harper

The American pitcher-plants (family Sarraceniaceae), which are totally unlike any other plants in the Western Hemisphere, though distantly related to the Old World family Nepenthaceae, have long attracted popular attention on account of their carnivorous habits and striking appearance. The family comprises three genera, with nine known species, a few subspecies, varieties, or abnormal forms, and several hybrids; all perennial herbs, growing in damp sandy soils and boggy places in temperate climates. They have nearly all been cultivated for ornament in Europe, especially in Great Britain and Ireland, where several horticultural varieties and artificial hybrids have originated.

The leaves of all the species arise from subterranean rootstocks, and are normally tubular, with a longitudinal wing on the anterior side. This tube corresponds with the petiole of ordinary leaves, and is usually surmounted by an appendage known as the hood, varying greatly in shape in different species, which corresponds to the leaf-blade. So odd are the shapes of the leaves of some species that it is impossible to describe them adequately in words, and for this reason it has been difficult to interpret correctly some of the early descriptions that were unaccompanied by figures, and some confusion in nomenclature has resulted.

In some of the species the leaf-tubes are wide open to the sky, and in others the hood is curved over the mouth of the tube in such a way that no sunshine or rain can enter directly. In the latter case the convexity of the hood is always provided with numerous white translucent spots which serve to illuminate the interior, the advantage of which will appear presently. A red pigment (anthocyan) is quite characteristic of the family, appearing in varying degree in both leaves and flowers. It is generally best developed in plants growing in sunny places.

The leaves contain more or less liquid, which in the species with open tubes is mostly rain-water, but in the others is a secretion from

the plant. Late in the summer the tubes are usually half filled with dead insects of many species, which have been lured thither by the bright colors of the hoods, or a sugary secretion on the outside of the tubes, or both. Just within the mouth of the tube the surface is so smooth that it affords a very insecure foothold, and a little farther down is a close array of stiff hairs pointing downward, which make descent very easy and ascent by crawling almost impossible. And the tube is usually too narrow for an insect of any size to fly out after it once gets inside. The function of the "windows" in the over-arching hoods is now evident, for flying insects as a rule do not like to enter dark places. Once within the zone of downward-pointing hairs, death by drowning is almost inevitable; and human ingenuity could hardly devise a better fly-trap than a pitcher-plant leaf.

There are, however, a few species of insects which in the course of ages have learned to circumvent these elaborate pitfalls and even to profit by the misfortune of their less wary fellow-creatures. In many of the leaves can be found one or more larvae feeding on the carcasses, and these when the proper stage in their development arrives escape by gnawing their way out, or perhaps in some cases by flying. Occasionally a spider spins its web across the tube and robs the plant of some of its prey. Or when there is more water than insects mosquitoes may use these natural pitchers for breeding-places.

There has been some difference of opinion as to whether the pitcher-plants actually digest the insects entrapped in their leaves; and doubtless the digestive action is less easily demonstrated in some species than in others, and may take place only during a brief period of the year. But the conclusion is irresistible that such highly specialized contrivances must be of some advantage to the plant, and when the leaves finally decay the insect remains in them must contribute in no small degree to the nutrition of the plants through their roots, if nothing else.

The flowers of all the species are rather showy and more or less odorous, but last only two or three weeks, and only a minority of the plants in a given area seem to bloom in any one year. In the South American species there are several flowers on one stalk, but in the

others there is only one flower to a plant. In *Sarracenia,* the largest genus, the flowers are borne on erect naked stalks (scapes), from less than a foot to over two feet tall. At blooming time, which ranges from March in Florida to August in Labrador, the top of the scape is bent over so that the flower hangs downward. After the petals and stamens fall the axis of the flower assumes a more or less horizontal position, and the sepals and pistil together with the great umbrella-like stigma turn green and remain without further change until late in the fall, when the seeds are ripe. Just how the seeds are transported from place to place is not known, but very likely become attached to the feet of migrating birds in some way, for some of the species have a wide and rather sporadic distribution.

One of the genera, *Heliamphora,* with a single species, is known only from Mt. Roraima in British Guiana, where it was discovered about 1838 by Sir Robert H. Schomburgk, a noted explorer, who surveyed the boundary between British Guiana and Venezuela, and also discovered the *Victoria regia,* the giant of the water-lily family. It grows in rather inaccessible places, but has been seen by a few subsequent explorers.

Another genus, *Darlingtonia* (more recently called *Chrysamphora* on account of a conflict in nomenclature), likewise with a single species, is confined to the mountains of Oregon and California. The remaining genus, *Sarracenia,* is confined to the southeastern United States between latitudes 28° and 36°, except that one species extends a little way into Virginia and another far into Canada, almost to the Arctic Circle. Like many other bog plants, they are most abundant in regions where most of the precipitation comes in the warmer half of the year and thus counterbalances the evaporation to a considerable extent. The flowers of the seven species of this genus are all much alike except in color (some being red and some yellow) and size, but the leaves are very diverse. Some of the species regularly, some occasionally, some never, produce in addition to the normal insect-catching leaves sword-like ones consisting of wing only, without tube or hood, or in some species there are all gradations between normal and tubeless leaves (phyllodia). The phyllodia are chiefly produced in cool

shady places, or in the fall to last through the winter, but what benefit they may be to the plant is not obvious. The normal leaves are perfectly evergreen in the species in which they lie close to the ground, and die down in the fall in the taller species; and there are various intermediate conditions.

The leaves of the southern species are called "pitchers," "bugles," "fly-catchers," "lilies," or "trumpet-flowers" by the natives and the fruits, or spent flowers, which they perhaps do not always recognize as being a part of the same plant, are sometimes known as "ladies' watches," or simply watches. The northern species is sometimes called "side-saddle flower" or "huntsman's cup."

The hybrids are of course all in the genus *Sarracenia* (for the single species in the other two genera have no near relatives to hybridize with), and they grow wild only between the James and Mississippi rivers, for elsewhere no two species grow in proximity. For a small genus, whose representatives all grow in strictly natural habitats and shun civilization, the number of hybrids is remarkably large. Artificial hybrids were produced in European greenhouses more than forty years ago, before the existence of natural hybrids was definitely known, and now there are more such hybrids than there are species, not counting compound hybrids, of which there are several. Natural hybrids were first recognized about twenty-five years ago, and we now know at least five simple combinations and one probable compound.

It has been my good fortune to see in their natural surroundings all the North American species of this family and nearly all the known wild hybrids, and to take photographs of about half of them in the field. In the next few pages are brought together some notes on the history, habits, and distribution of these plants, including quite a number of facts and photographs not previously published. The distribution is given in some detail, for the benefit of readers who may wish to seek the plants in their native haunts.

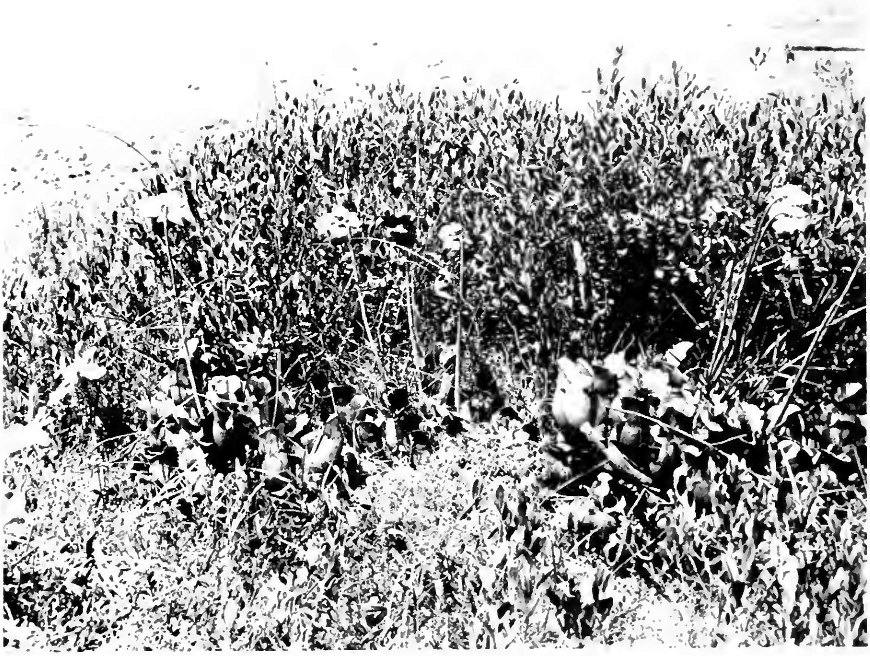
The western pitcher-plant, *Darlingtonia californica*, grows in mountain meadows in and near the Cascade Range, in southwestern Oregon and northern California, between the 39th and 44th parallels of latitude, and from near sea-level to 8,000 feet above. It was dis-

covered by J. D. Breckenridge, assistant botanist of the Wilkes exploring expedition, a few miles south of Mt. Shasta, in October, 1842; but the flowers, without which the plant could not be properly characterized, were not known until they were collected near the same place by Dr. G. W. Hulse in 1851. It was described and named by Dr. John Torrey of New York in 1853.

The leaves are reddish or yellow with translucent spots, usually less than a foot tall but sometimes over three feet, and twisted 180° so as to bring the opening under the arched hood to the outer side of the clump. An appendage resembling a fish-tail, a couple of inches long, which has no counterpart in the other members of the family, hangs in front of the orifice (which opens downward), and is more or less covered with nectar. Whatever liquid is in the leaves must be secreted by them, for rain cannot enter from above, and there is very little rain in that part of the country anyway, for most of the precipitation comes in winter in the form of snow. It is said to bloom from May to July. I was a little too late to see the flowers when I made a special visit to one of the southernmost known localities for it, in Plumas County, California, immediately after the A. A. A. S. meetings at Berkeley in 1915. The plants at that locality are so surrounded by grass and other vegetation that it is not easy to photograph them in their natural setting, but the accompanying illustration gives a good idea of the general appearance of small specimens without flowers.

The northern pitcher-plant, *Sarracenia purpurea*, is the most widely distributed species of the whole family, and naturally the best known (Pl. 2). Just when and where and by whom it was first discovered is not certainly known, but there is an unmistakable figure of it in Clusius's *Rariorum Plantarum Historia*, published in Amsterdam in 1601. The genus is named for Dr. Michel Sarrasin (or Sarrazin) of Quebec, who flourished a century later, and sent specimens of this plant among others to Tournefort, in Paris, who was one of the founders of systematic botany. The early herbalists who wrote about it thought it to be a near relative of *Limonium* (a genus including the common sea-lavender of our salt marshes, which indeed it does resem-

PLATE 2



SARRACENIA PURPUREA. Salisbury, Connecticut.

ble slightly in the position and texture of its leaves). The names *Bucanephyllon* and *Coilophyllum* had also been applied to it before Tournefort's time; but our nomenclature dates from Linnæus (1753), who adopted Tournefort's generic name for this plant.

It is fairly common in sphagnous bogs in the glaciated region from Newfoundland and the Northwest Territories to Wisconsin and northeastern Pennsylvania. South of the terminal moraine it is known in a few places in southern Pennsylvania and one station in Maryland (near Baltimore), and is fairly common in the pine barrens of New Jersey. Then there is a gap in its known range, and the remaining localities are south of Virginia and east of Mississippi River. It has indeed been reported in the past from Virginia, Kentucky, Tennessee, and Louisiana but without definite locality, and no botanist now living seems to have seen it in those States (or in West Virginia). Possibly some former stations for it may have been destroyed by drainage operations. In North Carolina it is found in many of the "pocosins" in the southeastern part of the State, as well as in a few places among the mountains; and in South Carolina it occurs sparingly both in the sand hills of Chesterfield County and in the flat pine-barrens in the southern part. In Georgia it has been found only three or four times, in Randolph, Lee, and Tattnall counties. (And in the last named I was unable to find it in 1915 in the same place where I had collected specimens in 1904, though the spot did not seem to have been tampered with in the interval.) In West Florida and southwestern Alabama, however, it is quite common in gently sloping wet pine-barrens, and does not differ perceptibly from the New England plant. Farther west it becomes scarcer again, and, as stated above, it is not now known to grow in Louisiana.

The leaves form a rosette, and as a rule lie half buried in moss, with the mouths of the pitchers wide open to the sky, so that they must be filled to overflowing by almost every shower. The hoods are paler than the tubes, but are more or less mottled and streaked with red. Variations occasionally found are yellowish leaves and flowers, and leaves with tube and hood almost wanting. The flowers are normally purplish red, and unfold from April to August accord-

ing to latitude. The leaves are perfectly evergreen, and must be capable of enduring freezing temperatures for several months at the northernmost stations.

Sarracenia psittacina, the smallest member of the genus, resembles the preceding in having the leaves widely spreading in a rosette, and in being very similarly colored. They are quite differently shaped, however, and usually smaller and more numerous than those of *S. purpurea.* The usual type of leaf, found in flat sandy pine-barrens, is short and prostrate, with a comparatively narrow wing, and of a prevailing reddish color except for the white "windows" in the hood. The other extreme of leaf-form, found chiefly in shaded sphagnous bogs, is obliquely ascending, with a broad wing, long tube—sometimes eight or ten inches long—and small hood, and much paler in color. In either case the plant hardly ever stands out above its neighbors sufficiently to be photographed satisfactorily, and it is scarcely visible until one is within a few yards of it. It differs from all its congeners, and resembles *Darlingtonia,* in having the entrance to the pitcher a small round opening on the inner side of the globose hood, which bears little resemblance to any ordinary leaf-blade. The leaves, although of rather thin texture, are evergreen or nearly so, like those of many other rosette-forming plants, particularly in such mild climates. The flowers are red, on stalks usually not over eight inches tall.

This species seems to have been found first by William Young, Jr., "Queen's Botanist," who collected plants in the Carolinas in 1766-1768. But he must have gone into Georgia to get it, for it is not known east of the Savannah River, and it escaped the notice of Thomas Walter, who published a "Flora Caroliniana" in 1788, and even of Stephen Elliott, who published a "Botany of South Carolina and Georgia" in 1816-1824. It was first described in 1803 in the "Flora Boreali-Americana" by Andrè Michaux, a French botanist who traveled extensively in all parts of North America that were settled at the time of the Revolution. He said it grew "from the city of Augusta, Georgia, to Florida"; but it is not now known within sixty miles of Augusta, the northeasternmost known locality for it being in Bulloch County, Georgia. From there it ranges northwestward

PLATE 3

(*Right*) SARRACENIA MINOR. Okafinokee Swamp, Georgia.
(*Left*) SARRACENIA MINOR, WITH THE AUTHOR. Okafinokee Swamp, Georgia.

through middle and west Florida to southeastern Louisiana; and in almost every county within its range it is common enough so that one can find it almost any day by looking in favorable places.

Sarracenia minor (Pl. 3) has leaves erect or nearly so, with the hood curved over the mouth of the tube in such a way as to keep out rain falling vertically, though in heavy showers some rain may splash into it. The back of the hood has numerous white translucent spots which serve to light up the interior of the pitcher, and the wing has minute nectar glands scattered along it, which lead ants and other crawling insects up to the mouth of the tube and to destruction within. The leaves are usually less than a foot tall, but in Okefinokee Swamp, Georgia, a height of three feet is often reached, and I have measured one leaf forty-four inches long. (See illustration.) They last pretty well through the winter, but apparently do not function a second season. The flowers are yellow.

This was figured by some of the old European herbalists over two hundred years ago, but was first properly described by Walter in 1788. Michaux, overlooking Walter's description or not recognizing it as belonging to his own plant, redescribed it in 1803 as *S. variolaris*, and this name prevailed for one hundred years, until the older name was resuscitated by the writer.*

This is a common, though not very abundant, plant, chiefly in damp flat pine-barrens, from southern North Carolina to southwest Georgia and southward to the vicinity of Kissimmee, Florida, which is about one hundred miles farther south than any other species of *Sarracenia* extends.† It is not known in Alabama, but Professor J. M. Macfarlane found it once near Ponce de Leon in west Florida. It can often be recognized from a moving train, especially when it is in bloom.

Sarracenia rubra is a slender dull-colored plant with leaves and flower stalks about a foot tall, or sometimes more, but usually less.

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*Bull. Torrey Bot. Club **30**:331-332. 1903.

†In an article on the Everglades by Dix and MacGonigle in the *Century Magazine* for February, 1905, there is a sketch purporting to show some of the characteristic plants of the islands, in which a Sarracenia (species unrecognizable) appears growing on the trunk of a tree with some orchids and ferns! The artist, however, carried his poetic license too far not only in making Sarracenia an epiphyte, but also in attributing it to that part of Florida at all, for no member of the genus is known within one hundred miles of the Everglades.

The leaves are erect or nearly so, with tubes an inch or less in diameter at the top, and roundish ascending hoods with dark red veins. The flowers are red, as the name implies. A double-flowered form has been found by Dr. W. C. Coker near Hartsville, S. C.*

Like the preceding, this was first described by Walter in 1788. It is probably the least abundant member of the genus, and a person unacquainted with it might look for it for several days without finding it. It is so inconspicuous that it never figures in car-window notes. But it has a fairly wide distribution, from North Carolina to west Fliroda and southeastern Mississippi. It is not confined to the pine-barrens,† but grows equally well in the region of mixed pine and hardwood forests a little farther inland, also among the fall-line sandhills, and even in a few places among the mountains of North Carolina, over 2,000 feet above sea-level.‡ Apparently no one has yet photographed it in its natural surroundings.

Sarracenia Sledgei is intermediate in many respects between the preceding species and the next, and might be regarded as a hybrid between them, but for the fact that it grows in many places far removed from either. (Of course it is conceivable that a plant of hybrid origin might perpetuate itself and extend its range over a considerable territory, and it has been suggested that many if not most species have originated in that way; but no authentic case of a self-perpetuating hybrid growing under perfectly natural conditions seems to be known.)

The oldest known specimens of this plant were collected by Thomas Drummond in southeastern Louisiana in 1832; but it was quite generally confused with *S. flava* until separated by Professor J. M. Macfarlane of the University of Pennsylvania, our greatest authority on this family of plants, in 1904. At that time, however, he erroneously identified it with Elliott's *S. Catesbaei* (of which more anon). Discovering his error a couple of years later, the plant was left without

*See Plant World **12**:253-254. 1909; Plant Life of Hartsville, p. 80. 1912.

†For a map showing the approximate location of the southeastern pine-barrens see Journal of Geography **15**:42. Oct. 1916.

‡An amateur botanist in middle Georgia told me several years ago that he had seen a *Sarracenia* in the northern part of Newton County; which is the only record of the occurrence of that genus in Georgia outside of the coastal plain. I never had an opportunity to visit the locality, but would not be much surprised to find *S. rubra* there.

PLATE 4

(*Above*) SARRACENIA FLAVA var. OREOPHILA. Cherokee County, Alabama.
(*Below*) SARRACENIA FLAVA. Colquitt County, Georgia.

a name, and early in 1907* he named it after Dr. W. H. Sledge, of Mobile, who first sent him specimens of it.

It is fairly common in wet pine-barrens from the west side of Mobile Bay to eastern Louisiana, and has been collected in Smith, Henderson, and Hardin counties, Texas; being the only southern pitcher-plant known west of the Mississippi River. East of Mobile Bay I have seen a few specimens in the southern part of Baldwin County, Alabama, and what appears to be the same thing (though it may be a variety of the next) in boggy places among the long-leaf pine hills in Chilton and Autauga counties, near the center of the State.

Sarracenia flava (Pl. 4) is a showy plant with straight erect trumpet-shaped leaves averaging about a foot and a half tall, and two inches or so in diameter at the mouth of the tube. They are bright lemon yellow (or green in shady places), with an irridescent purple spot, or a cluster of purple veins, on the throat or neck, which doubtless serves to lure insects to their destruction. Unlike most of the species previously enumerated, this regularly bears two very different kinds of leaves. The conspicuous insect-catching ones die down in the fall, and are immediately succeeded by green sword-like ones somewhat shorter, which last through the winter. (See illustration.) The flowers are yellow, on stalks usually shorter than the leaves; and there are few flowering plants so nearly yellow throughout as this one.

This striking plant was probably first collected at least three hundred years ago by some of the early botanical explorers of Virginia and North Carolina, and it was in cultivation in Europe soon afterward. The present name dates from the time of Linnaeus. It is doubtless the most abundant plant of its family, though not the most widely distributed. In some parts of its range, particularly in Georgia, there may be as many as ten thousand plants to the acre, making a mass of bright color that can be seen from afar. Its favorite habitat is sandy gentle slopes perpetually moistened by seeping water; it is rarely found in flat pine woods, in ponds, or in peat bogs. It extends from a few miles south of Petersburg, Virginia,† southward

*Journal of Botany **45**:1. Jan. 1907.
†See Torreya **4**:123. Aug. 1904; Bull. Torrey Bot. Club **34**:371. 1907.

to middle Florida (Wakulla County), and westward to Baldwin County, Alabama, where it is rather scarce. Its range does not seem to quite meet that of its near relative, *S. Sledgei.* In North Carolina it is common among the fall-line sandhills (where a traveler on the main line of the Seaboard Air Line can see it any day in summer), as well as nearer the coast, and it is known also in the Piedmont region; but in Georgia it seems to be confined to the pine-barrens.

Several minor horticultural varieties of this species, based on color differences, have been described, and there is a wild variety that deserves special mention. In northeastern Alabama, particularly on the Cumberland Plateau in Marshall, Jackson, and DeKalb counties, and in the Coosa Valley in Cherokee County, in moist sandy places near streams, is a plant similar to *S. flava,* but not typical of that species. It was found by two or three collectors in the last decade of the nineteenth century, and was referred by Dr. Charles Mohr in his *magnum opus*, the plant life of Alabama,* to the long-lost *S. Catesbaei* of Elliott, which was described from South Carolina three-quarters of a century before. Almost contemporaneously Mr. T. H. Kearney, in a discussion of the distribution of certain coastal-plain plants represented by identical or closely related forms in the Southern mountains,† applied the name *Sarracenia flava var. oreophila* to it, but gave no description. Besides the slight differences pointed out by Dr. Mohr, who saw the plant only in summer, there is another that may be important. The sword-like winter leaves, instead of being nearly straight as in the pine-barren form illustrated herewith, are strongly recurved, and considerably shorter than the summer leaves. But this plant should be studied a little more before it is formally named. What appears to be the same thing was collected, probably in the third quarter of the last century, by Dr. Hugh M. Neisler, who lived at Butler, Georgia, among the fall-line sandhills, and presumably got his specimens somewhere in that neighborhood.

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*Contr. U. S. Nat. Herb. **6**: 79, 531. 1901. See, also, Mohr, Bull. Torrey Bot. Club **24**: 23. 1897; Harbison, Biltmore Bot. Stud. **1**: 155, 156. 1902; Harper, Torryea **6**: 114. 1906.

†Science II. **12**:833, 837. Nov. 30, 1900.

PLATE 5

(*Above*) SARRACENIA DRUMMONDII. Walton County, Florida.
(*Below*) SARRACENIA DRUMMONDII. Mobile County, Alabama.

Sarracenia Drummondii (Pl. 5) has leaves of about the same size and shape as those of *S. flava*, except for being a trifle slenderer; but the upper parts are white with a network of reddish veins, and the lower parts green; the hoods are covered with stiff hairs on the inner surface, and the flowers are red. It produces some sword-like leaves in the fall, but not so regularly or abundantly as does *S. flava*.

This handsome plant was apparently first noticed near Pensacola, Florida, early in August, 1775 (or 1777?*) by William Bartram, a noted naturalist of that time, who attempted to describe it in his Travels (1791) under the name of *S. lacunosa*; but he seems to have gotten *S. minor*, which does not grow so far west (or possibly *S. Sledgei*, which does not grow so far east) mixed with it in his memory, for his description fits *S. minor* better. C. C. Robin, a French explorer who was not a botanist, traveled through the South from 1802 to 1806, saw the same plant near the same place, and published a recognizable description of it in his narrative (1807), although he mistook the leaves for flowers, as many other non-botanists have done since. The erratic naturalist Rafinesque ten years later dug out this description and applied the name *Sarracenia leucophylla* to it, but that has never been taken seriously on account of Rafinesque's well-known eccentricity and his rather unwarranted procedure in giving a name to a plant he had never seen, on the strength of an imperfect description. The species was first properly described in 1836 by H. B. Croom, who did not refer to Bertram or Robin, but had seen specimens collected near Appalachicola by Drummond in 1835 and by Chapman in 1836. (These same old specimens are now in the Torrey Herbarium at the New York Botanical Garden.)

It is known in a few places in southwest Georgia, and inland in Alabama as far as Crenshaw County, is abundant in west Florida and southwestern Alabama, but stops rather abruptly near the Alabama-Mississippi line. It grows in sandy bogs, and especially in the wet gently sloping savannas which are very characteristic of the coun-

*The dates in different chapters of Bartram's Travels are inconsistent, and no one seems to have determined which ones are correct. There is a little contemporary evidence in Darlington's "Letters of Bartram and Marshall," and more may yet turn up.

try within fifty miles of Mobile Bay. In some places it is just as abundant and conspicuous as *S. flava* is farther east.

The known natural hybrids will now be discussed briefly. It is not necessary to describe them, as each is almost exactly intermediate in appearance between the parent species. They bloom less frequently than the true species, and the flowers of one or two have never been seen at all. They are nearly always found in the immediate vicinity of their parents. *Sarracenia purpurea* is the parent of two of the known hybrids, *S. psittacina* of one, *S. minor* of two, *S. flava* of three, and *S. Drummondii* of two. No natural hybrids of *S. rubra* are certainly known, though Asa Gray in the first volume of his Synoptical Flora of North America (published in 1895, several years after his death) mentions the existence of plants which appear to be hybrids between this and *S. purpurea*, but without giving any locality. No hybrids of *S. Sledgei*, the most recently described species, have yet been reported, but their existence is not at all unlikely, for there are three other species that associate with it.

Sarracenia purpurea x *flava* has quite a long history. One of the colored figures in Catesby's "Natural History of Carolina," first published in 1743, has been thought to represent it, but the figure is a poor one, and is probably intended for *S. flava*, which Catesby could hardly have helped seeing on his travels, and does not mention otherwise. Early in the nineteenth century Dr. James Macbride collected in Chesterfield County, South Carolina, a pitcher-plant without flowers, which was described by Elliott in 1821 in his "Botany of South Carolina and Georgia" as *S. Catesbaei*, on account of its supposed resemblance to Catesby's figure. The other *Sarracenias* known to Elliott were *purpurea, rubra, flava,* and *minor,* and of these he said the new plant was most closely related to *flava*. Croom, examining the same specimen a few years later, asserted that it did not differ materially from *S. flava;* but Professor Macfarlane, who saw it about 1906, recognized it as this hybrid, which he had already known for some years.

In the *Gardeners' Chronicle* (London) for July 9, 1881, there is a brief notice of a plant called by British horticulturists *Sarracenia Williamsii,* which had been received in a shipment of plants from

PLATE 6

(*Above*) SARRACENIA FLAVA x MINOR. Coffee County, Georgia.
(*Below*) SARRACENIA FLAVA x DRUMMONDII. Geneva County, Alabama.

America (locality not specified), and was thought to be a natural hybrid between *purpurea* and *flava*. In June, 1893, Professor Macfarlane found two specimens, in company with the parent species, near Wilmington, N. C., where their hybrid origin was practically certain. In 1905 he found 117 specimens of the same thing in one day in Holmes County, Florida, and a few in Baldwin County, Alabama. The same two species were crossed to make one of the first artificial hybrids in the genus, in 1874.

S. purpurea x *Drummondii* was discovered in company with its parents in Baldwin County, Alabama, by Professor Macfarlane in 1905, and in the northern part of Walton County, Florida, by the writer in 1911. Artificial hybrids with this parentage were described in England in 1887.

S. psittacina x *minor* was found by the writer in Colquitt County, Georgia, in 1902, and in Coffee, Irwin (now Ben Hill), and Wilcox counties in 1904.* All these localities are in the Altamaha Grit region or rolling wire-grass country. This hybrid produces flowers and fruit more freely than most of the others. Artificial hybrids were known in England as long ago as 1881, under the name of *S. formosa*.

S. flava x *minor* (Pl. 6). No artificial hybrid between these two yellow-flowered species is certainly known, but in 1901 I found a single specimen of the natural hybrid in Bulloch County, Georgia, and the following year several others in Coffee County.† Of the photographs taken at the latter place in 1902 and 1904 two have been published already, and another appears here. Professor Macfarlane found the same thing near Summerville, S. C., in 1903.

S. flava x *Drummondii* (Pl. 6). These two species were probably the first to be crossed artificially, this having been done by Dr. David Moore at Glasnevin, Ireland, in 1873, or thereabouts. The first intimation of a natural hybrid between them seems to be in the 1893 catalogue of Pitcher & Manda, florists, of Short Hills, N. J., where there is a full-page halftone of a plant called *Sarracenia Mandaiana*, said to "have been collected growing in company with *S. flava* and *S. Drummondii*, of which it is no doubt a natural hybrid." In 1895 and 1901,

*Bull. Torrey Bot. Club **33**: 236, 237. 1906.
†Bull. Torrey Bot. Club **31**: 22. 1904; **32**: 163. 1905.

at two places about a mile apart near Americus, Georgia. I found a few specimens corresponding very well with that illustration (which happened to come into my possession in the former year). *S. rubra* and *S. Drummondii* were growing close by in both places, but the nearest known station for *S. flava* was (and is) over twenty-five miles away, which made me doubt the possibility of that's being one of the parents, or of my plant being a hybrid at all. The flowers were unknown to me, as they were to Pitcher & Manda. In 1903* I referred it to the problematical (and likewise flowerless) *S. Catesbaei,* but Professor Macfarlane's investigations of that plant, published in 1907, showed that I was mistaken. In June, 1906, I found some very similar plants (illustrated herewith) about three miles east of Geneva, Alabama, in company with *S. Drummondii*, though here again there was no *S. flava* (nor *S. rubra*) in sight. But in the meanwhile Professor Macfarlane in 1905 had found plants whose hybrid origin was evident near Bay Minette, Alabama.

The occurrence of this plant remote from one of its supposed parents is somewhat of a puzzle. Whether *S. flava* had once grown nearer by and its hybrid progeny had maintained itself independently for a long period, or the pollen can be carried by insects much farther than we realize, or the supposed hybrid is really a mutation or a valid species, remains to be proved.

One compound natural hybrid has been reported by Professor Macfarlane, who has found near Ponce de Leon, Florida, what appears to be *S. purpurea* x *flava* crossed again with *S. flava*. The artificial hybrids that have no known wild counterparts need not be discussed here, as they are known only in European greenhouses and have no status as American plants.

The known distribution of the species of *Sarracenia* in the United States may be summed up by States as follows: East of the Great Plains and north of the Ohio and Potomac rivers *S. purpurea* is found in every State, with no other species of the genus. In West Virginia, Kentucky, and Tennessee apparently no pitcher-plant has been seen by any botanist now living, though *S. purpurea* has been

*Bull. Torrey Bot. Club **30**: 333-335. 1903.

reported more or less indefinitely from the last two. In Virginia only *S. flava* is certainly known (and that is scarce), but there are vague references to *S. purpurea* in the literature. (In the remaining States the species will be listed as nearly as possible in order of abundance.)

North Carolina has four species: *flava*, *purpurea*, *minor*, and *rubra*; and one hybrid, *S. purpurea* x *flava*.

South Carolina has the same, probably in the same order of abundance, with *S. minor* x *flava* added.

Georgia has six good species, *flava*, *minor*, *psittacina*, *Drummondii*, *rubra*, and *purpurea*, possibly also the subspecies *S. flava oreophila*, two unmistakable hybrids, *psittacina* x *minor* and *minor* x *flava*, and what appears to be *S. flava* x *Drummondii*.

Florida has the same true species as Georgia, but in a different order, about as follows: *minor*, *psittacina*, *Drummondii*, *flava*, *purpurea*, *rubra*. Also two simple hybrids, *purpurea* x *flava* and *purpurea* x *Drummondii*, and what appears to be a compound hybrid.

Alabama has six species, *Drummondii*, *purpurea*, *Sledgei*, *flava*, *psittacina*, and *rubra*, one subspecies, *flava oreophila*, and three hybrids, *purpurea* x *flava*, *purpurea* x *Drummondii*, and *flava* x *Drummondii*.

Mississippi has *Sledgei* and *psittacina*, and possibly also *purpurea*, *rubra*, and *Drummondii* at the extreme eastern edge of the State.

In Louisiana only *Sledgei* and *psittacina* are certainly known, and in Texas only *S. Sledgei*.

Naturally a great deal has been written about this interesting family of plants, but the short notes, other than a few already cited in the foregoing pages, are too numerous, and the longer papers mostly too inaccessible, to be mentioned in a popular article like this. It must be acknowledged here, however, that most of the facts above set forth that are not based on personal experience are taken from Professor Macfarlane's writings, particularly his 39-page monograph of the family in Engler's Pflanzenreich, published in 1908. That contains references to the most important previous literature, some of which I have also used.

COLLEGE POINT,
LONG ISLAND.

EXTENSION OF THE RANGE OF *PRUNUS UMBELLATA* INTO NORTH CAROLINA

By J. S. Holmes

During a study of the forest conditions of Stanly and other southeastern Piedmont counties last summer (1917) I came across a species of plum tree which I had not before seen. Having no books with me, I sent a specimen to Dr. W. C. Coker of the State University and he immediately identified it as *Prunus umbellata.*

The two species of plum common to North Carolina are *Prunus americana,* the hog plum, and *Prunus augustifolia,* the chickasaw plum. These two are generally distributed throughout the State, though the former is more abundant in the upper districts and the latter in the middle and lower districts.

The fruit of *Prunus umbellata*, known frequently as the sloe or bullace plum, is much smaller than that of either of the above species. It can hardly be classed as edible, being very sour and bitter; however, it is used to some extent in making jelly, probably mixed with the larger and more palatable fruit of the other two species. The tree is small, the largest one seen not exceeding six inches in diameter and twenty-five feet in height; the twigs are slenderer and less stiff than the chickasaw plum and the tree is hardly as tall or as large as the hog plum, which it more nearly resembles. It occurs in old-field pine stands and on the borders of fields and roadsides, usually in rather dry situations in sandy or gravelly soil.

Its distribution in North Carolina as established by me during last summer's field season is confined to the Pee Dee River region, in the counties of Anson, Stanly, Montgomery, and Richmond. It was most common within a few miles of the river, though in Stanly County it was seen twelve miles west of that river and in Montgomery County sixteen to eighteen miles east of it. The locality where it seemed to be most abundant was on the east side of Stone Mountain in Stanly County, a short distance below the mouth of the Uharie River and only a few miles south of its northern limit at Badin in the same

county. As far as I could learn, it is not distinguished from the other plums locally, all of them together being known as wild plums.

So far as I am aware, *Prunus umbellata* has not been known to occur nearer to us than the coast of South Carolina, and Dr. Charles S. Sargent of the Arnold Arboretum, probably our leading authority on the distribution of trees in the United States, so records it in his manual of the Trees of North America, published in 1905. In this work he gives the distribution as follows: Sandy bottom lands and along the borders of the forest of longleaf pine; South Carolina to Mosquito Inlet, Florida, usually in the neighborhood of the coast, and from Tampa Bay to western Louisiana and southern Arkansas.

In a letter recently received from Dr. Sargent he says:

> "I do not find in this herbarium any specimen from South Carolina, but it is so common in the coast region of Georgia that I feel quite sure that it grows in South Carolina. I have collected it near Augusta and we have Georgia specimens from McIntosh County, Milam, Thomasville, Bainbridge, and Albany."

Dr. Small, in his Flora of the Southeastern United States, gives its distribution as "about river swamps and hammocks, South Carolina, Florida, Louisiana, and Arkansas." Dr. Small distinguishes between this species and *Pruns injucunda*, which occurs in the granite districts of Georgia and Alabama, while Dr. Sargent makes the latter a variety of the former. The difference seems to be largely in the amount of pubescence; *umbellata* having little or none, while *injucunda* has pubescent twigs and the under side of the leaves are likewise pubescent. Trees with smooth thin leaves and others with quite pubescent leaves were found growing fairly close together in the Pee Dee region, and Dr. Sargent says in his letter to me that the species varies very much in pubescence, there being many specimens in the herbarium of the Arnold Arboretum which are more pubescent than those I sent him.

Miss Alice Lounsberry, in her charming popular work on "Southern Wild Flowers and Trees" says of *Prunus injucunda:*

"Hardly is there a tree or shrub of more delicate and chaste beauty than this wild plum when in full bloom and the tiny young leaves are just beginning to show themselves."

Of *Prunus umbellata* she says:

"It has a similar look to *Prunus injucunda.*"

Perhaps, then, this may prove to be a valuable addition to our ornamental trees, if not to our economic assets. Certainly in July when the reddish purple fruit is hanging in abundance from the slender twigs it is a very pretty sight. The fruit hangs on a long while and the leaves remain on in the fall considerably longer than they do on the chickäsaw plum. The photo given in Plate 7 shows a tree 5½ inches in diameter (4½ feet from the ground) and 20 feet in height. This tree was in an old-field pine stand one mile west of Gibson's Mill, Richmond County, North Carolina. The picture was taken by the author November 17, 1917.

In Dr. M. A. Curtis' "Woody Plants of North Carolina," published in 1860, he gives, in addition to our two common plums, the Sloe (*P. spinosa* Linn. ?). He says:

"I have seen this only in Lincoln County, where it was pointed out to me by Dr. Hunter, and called by the above name. As I have no notes upon this small tree, I am now in uncertainty whether it be identical with the English Sloe or Blackthorn, which is naturalized in some parts of the country, and is considered by the best botanists to be the parent of the common cultivated plum (*P. domestica*, Linn.)."

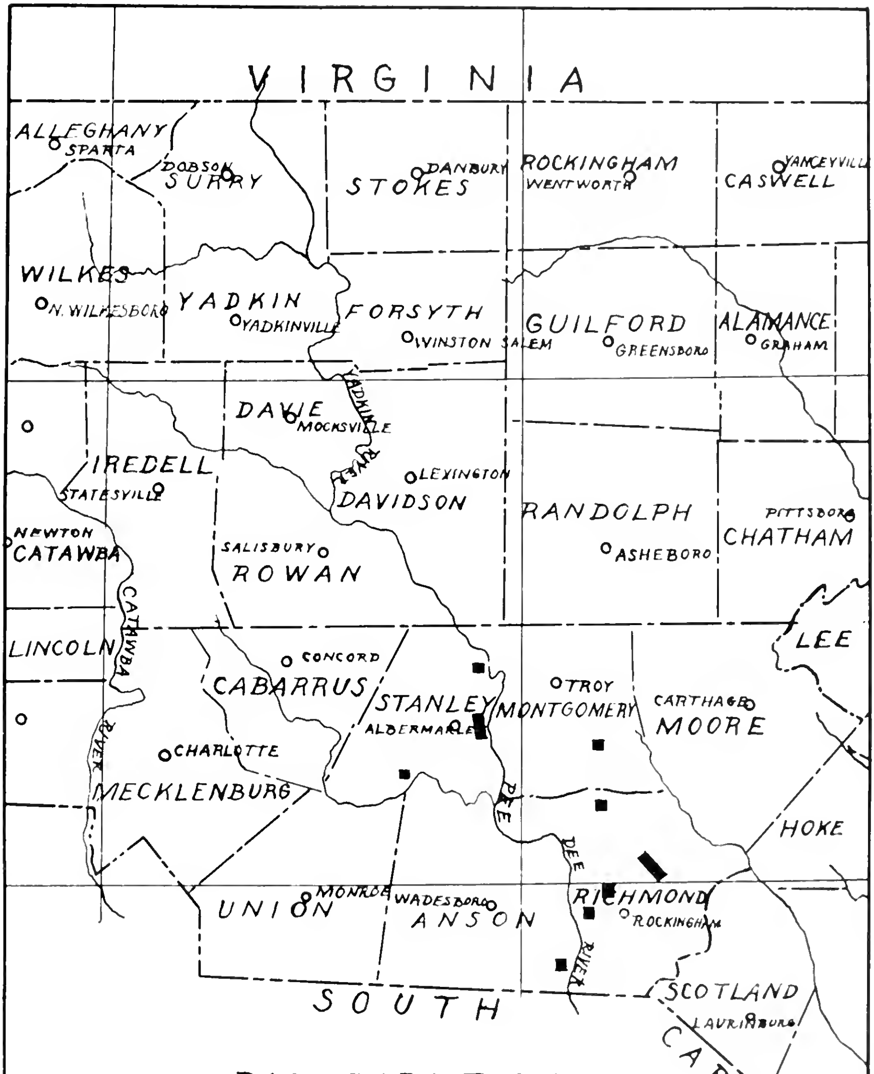
It is possible that this was an isolated specimen of *P. umbellata*, as the Lincoln County line is only about forty miles west of its known range in Stanly County, but neither this nor the Blackthorn, so far as I know, has been otherwise reported from North Carolina. The two trees are not much alike—the European Sloe or Blackthorn having sharp stiff thorns and the twigs themselves are stiff and unyielding. It spreads by shoots from underground rootstocks, these sprouts being used largely for making walking stick. The fruit is black with a bloom and is "intensely austere and astringent."

PLATE 7

PRUNUS UMBELLATA (SLOE OR BULLACE PLUM).

Photo by J. S. Holmes.

PLATE 8



DISTRIBUTION
OF
PRUNUS UMBELLATA
IN
NORTH CAROLINA
1917

The accompanying map shows by black rectangles the different locations where *Prunus umbellata* was seen.

These occurrences (Pl. 8) may be described briefly as follows:

ANSON COUNTY.

Morven Township, one mile south of Cairo.

STANLY COUNTY.

Big Lick Township, three miles east of Oakboro.
Albemarle Township, one mile north of Jacobs Creek on River Road.
W. M. Kirk's place east of Stone Mountain; and near Stony Mountain School.
Harris Township, one-half mile south of Badin.

MONTGOMERY COUNTY.

Rock Springs Township, near Harrisville.

RICHMOND COUNTY.

Steeles Township, Concord Church.
Rockingham Township, Zion Church and one mile south of Dockery's Store.
Beaver Dam Township, one mile west of Gibson's Mill, and near Beaver Dam Church.

CHAPEL HILL, N. C.

ADDITIONS TO THE ARBORESCENT FLORA OF NORTH CAROLINA

By W. W. Ashe

It was not intended by the authors* of the "Trees of North Carolina" to include all the trees in the State, since it is stated in the introduction that a number of others might be added. It might be well, however, to add to this already very full enumeration such others as are known to occur that the list may be as complete as possible. The addenda, omitting any hawthorns or semi-shrubs and allowing for the elimination of two from the original list by treating them as varieties, increases the number of species to 180 in place of 166. If to these are added the large number of smaller trees and semi-shrubs, including the arborescent hawthorns, the number nearly reaches 240, and with the inclusion of some of the best marked varieties exceeds 260. It is believed that even this total is incomplete, and that fuller investigations will further augment it, for many portions of the State have never yet been carefully explored.

Salix discolor Muehl. A small tree which occurs along mountain streams.

Betula papyrifera cordifolia (Regel) Fern. The canoe birch occurs in the Black Mountains but is not known to occur between this station and Connecticut and northern New York. (See *Rhodora,* Apl. 1918.) It is readily separated from the other birches on these mountains by its pinkish or brownish bark, which is in thin papery layers, as well as by its deeply cordate leaves, and declining, not erect, fruit cone.

Several forms of Hicoria (the generic name employed for *Carya* in Trees of North Carolina) are not noted.

Varieties of Hicoria pallida Ashe. This species varies much in the form of fruit and nut. The type can be considered the fruit form which is common around Chapel Hill and Raleigh, N. C., where

*W. C. Coker and H. R. Totten, Chapel Hill, N. C. Published by the authors 1916.

this tree was first studied. This form is shown in *Garden and Forest,* **10:** fig. 39, 5 and 6. The fruit is slightly oblong, compressed, rounded at both ends; nut compressed, slightly or not angled, rounded or subcordate at apex, pale brown or mealy; husk thin, usually splitting so as to free the nut. The following forms are sufficiently distinct to merit notice:

H. PALLIDA PYRIFORMIS n. c. (*Carya p.* var. Ashe: Bul. Charleston Mus. **14:** 11. 1918). Fruit slightly compressed, ficiform, 2-2.5 cm. long, with a distinct neck; not obovate, husk very thin not splitting so as to free the nut (Gard. & For. **10:** fig. 39, 7 and 8: 1897). Virginia to Alabama, in the Piedmont section and lower mountains.

H. PALLIDA ARENICOLA n. c. (*C. pallida* var Ashe, l. c.). Fruit large 2.5-4 cm. long, oblong but with a stipe, 4-angled by winged husk, nut oblong, more or less angled and pointed. Deep sandy soil in the coastal plain of North Carolina to Georgia.

H. PALLIDA APPOSITA n. c. (*C. pallida* var. Ashe, l. c.). Fruit oblong to slightly oval, 2-3 cm. long, somewhat compressed, husk 3-4 cm. thick, nut dark brown, angled, resembling that of *Hicoria alba* (Gard. & For. **10:** fig. 39, 9, 10, 11.

This tree is extremely close to *Hicoria buckleyi* (Dur.) n. c. (*Carya buckleyi* Dur.: Pro. Phil. Acad. Nat. Sci. **12:** 547), and fuller investigation may show that it is only a variety of *H. buckleyi*. The chief points of difference seem to be that the fruit of *buckleyi* is puberulent and subglobose. The fruit of all forms so far referred to *pallida* are glabrous. Pubescence of fruit is not considered a constant character in the shagbarks and may not be in this group. The fruits of nearly all species of this genus vary widely in shape.

HICORIA VILLOSA (Sarg.) Ashe has been regarded as being the same as *H. pallida* with very slight difference in fruit, that of *villosa* as originally figured (Sargent: Silva **7:** 167) being slightly obovate, the nut also being slightly obovate. The leaves in herbarium specimens show no characters which justify separating *villosa* from *pallida*. The plate of *villosa* (Sargent l. c.) shows the pistillate flower to be

different from that of *pallida*, especially in the absence of the broad stigmatic lobes, but is strongly suggestive of that of HICORIA ARKANSANA n. c. (*Carya arkansana* Sarg. Trees and Shrubs, **2**: 203. 1913), though the mature fruits are very different. A more careful study of the flowers and buds of *pallida* and *villosa* may furnish grounds for their separation, but at present it seems preferable to consider both of them as varieties of *pallida*, becoming respectively H. P. VILLOSA n.c., which is separated from the type by having usually fewer leaflets and more rusty pubescence; and H. P. ARKANSANA n. c., the twigs and buds of which are more or less pubescent. The color of the anthers is not constant, being either yellow or red, and *pallida* varies greatly in the scurfiness on the fruit. All of these forms are characterized by the peltate scales which clothe the lower surface of the leaves and which separates these species when free from pubescence from *porcina* and *ovalis* and when pubescent from *alba*, species which never bear such scales.

VARIETIES OF HICORIA ALBA (L.) Brit. This species has three forms in North Carolina: the typical with a medium-sized brown nut; *H. alba maxima* (Nutt.) Brit. with a very large, 3-5 cm. long dark brown 4-angled nut; and *H. alba albicans* n. c. (*Carya* var. Ashe, l. c.) with a small scarcely 2 cm. long sharply 4-angled white nut. The last two occur at Raleigh.

VARIETIES OF HICORIA OVATA (Mill.) Brit. In addition to the two shagbarks described in the Trees of North Carolina, three and possibly four varieties of *H. ovata* occur. One, *H. ovata nuttallii* (Sargt.)* n. c., differs from the type in the somewhat smaller but globose fruit and occurs associated with the type form throughout the western part of the State. As in the type the husk is sometimes puberulent on the outer surface.

The type and the above variety have the fruit grooved at the sutures of the husk and often impressed at apex and base. Another variety, *Hicoria ovata grandis* n. c. (*Carya ovata* var. Ashe, l. c.), has fruit as large or larger than in the type and often somewhat oblong, an even

*Carya ovata nutallii Sarg. T. & S. **2**: 208. 1913.

surface, full and rounded at the ends, and usually pubescent; the lower leaves often of 7 very large tomentose leaflets. It occurs through the Southern States from eastern North Carolina to Missouri, usually at low altitudes and in the larger river swamps. Another variety, *H. ovata holmesiana* n. c. was proposed as *Hicoria holmesiana*,* and was described as being smooth, having smaller fruit 2.3-3 cm. in diameter, smaller than the type. It was based on material from New England, the type coming from Mt. Tom. This form seems to be pubescent as well as glabrate. It occurs in North Carolina only in the higher mountains. A smaller tree in North Carolina than the common shagbark, it has only five smaller and usually less pubescent leaflets, and smaller subglobose fruit and nut; buds and twigs glabrate or pubescent but scarcely larger than those of the Carolina shagbark. This was originally proposed as a species and may be such. Another form which should be looked for in the western portion of the State and particularly in the mountains is *H. ovata fraxinifolia* n. c. (*C. var.* Sarg.: T. & S. **2**: 207. 1913). This has five very narrow leaflets, orange-brown twigs, and a thick spongy husk which is very rugose when dry.

HICORIA AUSTRALIS n. c. (*Carya* Ashe, Bul. Ch. Mus. **14**: 12). This shagbark occurs on the edges of swamps in the coastal plain south of Sampson County. It is a slender tree, 80 to 100 feet in height, about 2 feet in diameter, with bark scaly in long strips, and is closely related to the Carolina shagbark, being, when foliage is mature, essentially glabrous throughout, *including the fruit*, but is every way larger and stouter; twigs, buds, fruit, nuts, and leaflets which are broadly lanceolate and sharply serrate, those of the Carolina shagbark being much narrower. The fruit is glabrous, sulcate, and slightly impressed at each end.

VARIETIES OF HICORIA OVALIS (Wang.) n. c.† Dr. Sargent regards *ovalis* as being the oldest specific name applicable to this hickory, forms of which have been called *microcarpa* and *odorata*. This

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*Notes on Hickories (1896).
†*Carya ovalis* (Wang.) Sarg. T. & S. **2**: 208. 1913.

species and all of its varieties is the large tree, commonly called in North Carolina red heart or sometimes scaly bark (not shagbark) hickory, and is very common, especially on the red clay soils through the Piedmont. The ample lower leaves frequently have red petioles and the 5 to 7 leaflets are always dotted below with numerous resinous globules, which accounts for its balsmic fragrance in the early spring, hence Marshall's name *odorata* for this tree. Wangenheim in his ponderous German volume of 1787 has clearly described and figured the form he had before him: Fruit oval, rounded at the base, pointed at the top, the thin husk splitting to the base and freeing the nut, which is slightly oblong and flattened, and angled and pointed at the ends. This is *Hicoria microcarpa* (Nutt.) Brit.

*H. ovalis obcordata** n. c. This form has the "fruit subglobose to short oblong or slightly obovate, the nut compressed, broadest above the middle, rounded at base, and usually obcordate at apex." It is frequent especially in the mountains, but is not so common as the preceding.

H. ovalis odorata† n. c. This variety according to Dr. Sargent has fruit subglobose, flattened, husk thin, very glandular and splitting to the base, the nut whitish, thin-shelled, not ridged. This form has also been included under *H. microcarpa.*

H. ovalis obovalis‡ n. c. This is one of the frequent forms in the State and has the fruit obovate, and the compressed small nut of the same shape.

H. ovalis megacarpa n. c. Dr. Sargent has described *Carya megacarpa*§ from material from Rochester, N. Y. He associates with the Rochester form a tree which occurs in the immediate vicinity of the coast from near Beaufort, N. C., southward. It is closely related to and probably best regarded as a variety of *Hicoria ovalis.* This form has extremely large buds, the outer scales of which drop early, stout glabrous bright red-brown twigs; mostly 5 firm glabrous leaflets thickly dotted beneath with resinous globules and large fig-

**Carya ovalis obcordata* (M. & W.) Sarg., T. & S. 2:208. 1913.
†*Carya ovalis odorata* Sarg. T. & S. 2: 208. 1913.
‡*Carya ovalis obovalis* Sarg. T. & S. 2: 209. 1913.
§Trees and Shrubs 2: 201. 1913.

shaped fruit, approximately 2.5 cm. thick, the nut unangled, dark brown and thick walled, the husk nearly black when dry, thin, splitting only at top, not freeing the nut.

VARIETIES OF HICORIA PORCINA (Mx.) Raf. (*Juglans porcina* Mx. f.: Arb. Am. **1**: 306. 1810). This would seem to be, in the present state of our information, the preferable name for this species, rather than *Hicoria glabra* (Mill.) Brit. In addition to the type with five glabrous leaflets, destitute or nearly so of resinous globules on their lower surface and fig-shaped fruit on which the thin husk splits only at the top, the following other forms occur around Chapel Hill, N. C.: var. *hirsuta* n. c. (*Hicoria glabra* var. Ashe, Notes on Hickories), with the petioles and lower surface of leaflets soft white pubescent, the fruit as in the type; and var. *reniformis* n. c. (*Carya* var. Ashe, Bull. Ch. Mus. **14**: 2. 12), with subglobose compressed fruit almost without a stripe, and subcordate at apex. At Chapel Hill the pubescent form of this tree invariably has a fig-shaped fruit, while on a sandy ridge in the western part of Orange County, N. C., it has a short obovate fruit. *H. porcina acuta** (Sar.) n. c. should also be looked for in this State. It has fruit and nut pointed.

Another hickory which is to be looked for in southeastern North Carolina is H. SIMILIS n. sp. This is one of the most distinct of the *porcina* races and can be regarded as its South Atlantic coastal plain representative.

Leaflets prevailingly 7, rarely 5, somewhat larger especially broader than those of *porcina*, glabrous or essentially so before mature, by which time devoid of resinous globules. Twigs slender, dark redbrown (not purple brown as in *ovalis*), scarcely if any stouter than in *porcina;* terminal buds oblong-ovate, the outer scales short, carinate, bristle-tipped and persistent. Fruit ficiform, larger by one-fourth or one-third than that of *porcina*, nearly as large as that of *H. ovalis megacarpa* but more tapering at the base; husk very thin, splitting only at the apex; nut pale brown, obovate, slightly com-

Carya porcina acuta* Sarg. T. & S. **2: 200. 1913.

pressed, not angled, thick walled. A tree 10-20 m. tall, growing along the margins of pine barren swamps from Lumber City, Ga. (type locality) to Georgetown, S. C. The absence of resinous globules and the oblong-ovate buds ally this form to *porcina* rather than *megacarpa*.

VARIETY OF HICORIA CORDIFORMIS (Wang.) Brit. There is in addition to the typical form with the large obcordate nut, a form, *H. c. elongata* n. c. (*Carya* var. Ashe l. c.), with oblong acute fruit and an oblong pointed nut. It has been found only in the mountains of North Carolina.

QUERCUS PAGODA Raf. The swamp red oak is considered in the Trees of North Carolina as a species under the name *Q. pagodaefolia*. The form of the southern red oak with large thinly pubescent lower leaves, quite like those of the black oak and upper leaves in shape like those of the Spanish oak (*Q. coccinea*), but closely white pubescent beneath and fruit much like that of the swamp red oak, has been described as variety *leucophylla* of the southern red oak (Bul. Ch. Mus. Apl. 1917). Its affinities seem to be more with the swamp red oak than with the southern red oak, and if regarded as a variety of the former becomes *Q. pagoda leucophylla* n. c. This tree, which has very tough and valuable wood, is among the largest of American oaks.

QUERCUS OBTUSA (Willd.) Ashe. This is the common semi-evergreen water oak of the coastal plain and for industrial uses is the most valuable member of the water-oak group. The leaves are narrow, usually broadest near the middle, and longer than in *Quercus nigra*, and seldom noticeably 3-lobed. Those on vigorous shoots are not toothed and are usually unsymmetrical. The cup encloses about one-third of the nut.

QUERCUS AMBIGUA Mx. This is a form of the northern red oak which occurs on exposed sites in the higher mountains. It is not so

large as the typical form, from which is readily separated by the acorn cup being deeper and having a more pointed base.

QUERCUS MARGARETTA* is variable and some of the nearly related forms from the Gulf States which have recently been proposed by Dr. Sargent should be looked for in eastern North Carolina.

ULMUS FLORIDANA Chapm. This tree, which is confined to the swamps of the coast, is smaller in every way than the white elm. Its leaves are not quite so pubescent and the twigs are quite glabrous. It is common around New Bern.

PLANERA AQUATICA Gmel. occurs in the southern corner of the State.

CELTIS MISSISSIPPIENSIS Bosc., which has thin taper-pointed leaves, often with entire margins, occurs along the larger streams in the eastern part of the State.

CELTIS GEORGIANA Small, which is mentioned in the Trees of North Carolina as a shrub, frequently becomes a small tree, and should be included among the trees.

MAGNOLIA CORDATA Mx. (*Tulipastrum cordatum* (Mx.) Small) has been recorded only from the middle portion of the State, in the extreme northwestern corner of Moore or the adjoining part of Montgomery County. For the yellow-flowered form which has been reported from the mountains the name *Magnolia acuminata aurea* has been proposed (Bul. Ch. Museum **13**:28, 1917).

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*Dr Sargent has proposed (Bot. Gaz. 65, 441, May, 1918) several varieties of *Quercus stellata* Wang. which on account of their slender glabrous, or nearly glabrous, shining reddish-tan twigs would seem better regarded as varieties *Q. Margaretta*. These are Q. M. ARANIOSA n. comb. (*Q. stellata* var. Sarg. l. c.). This variety is based on material from Louisiana, the distribution being given from Alabama to Texas. It seems to differ from the type *Margaretta* only in the more floccose persistent tomentum on the lower surface of the leaves, the more slender branchlets and more scaly bark.

Q. M. PALUDOSA n. comb. (*Q. stellata* var. Sarg. l. c.). This is based by Dr. Sargent on trees growing in a swamp in St. Landry Parish, La. It seems to differ from *Q. Margaretta* only in its more uniformly 3-lobed leaves, the pubescence on the lower surface of which is shorter and more persistent, the sparingly pubescent twigs and more scaly bark.

Q. M. STOLONIFERA n. comb. (*Q. stellata* forma Sarg. l. c.). This variety found near Selma, Ala., is described as a shrub 1.5-2 m. high, forming thickets by subterraneous shoots. It differs further from the type in having smaller and narrower leaves. The same or a closely related variety grows along the Pee Dee River in Anson and Richmond counties, N. C., although it here reaches a somewhat larger size. It has the same characteristic method of vegetative propagation. It is locally known as runner oak.

To the arborescent* service trees can be added a variety and a species: AMELANCHIER LAEVIS CORDIFOLIA n. var., which has the leaves deeply cordate and more broadly ovate than in the type. It occurs in Rabun County, Ga., and foothills of the Blue Ridge in Macon County, N. C.

AMELANCHIER BEATA sp. nov. A virgate shrub or a small tree 3-8 m. in height. Leaf blades ovate to oblong-ovate, and rounded or subcordate at the mostly narrow base, or those at tips of twigs obovate and cuneate at base, 4-7 cm. long, 2-3.5 cm. wide, mostly taper-pointed, finely and regularly serrate, loosely pubescent or unfolding, especially below, nearly glabrous by maturity of fruit except the slender petioles $\frac{1}{3}$-$\frac{1}{2}$ length of blades. Flowers unknown. Fruit in 5-10-fruited strict compact racemes 4-5.5 cm. long, ripening early in June is 7-9 mm. thick, dark red-purple, glaucous, densely white woolly at the narrow summit, the narrow acute lobes erect or ascending from a carinate base; pedicels and axis more or less pubescent until fruit matures; lowest pedicels in fruit 12-20 cm. long. Style short, 2-2.5 mm. long.

Type from Toxaway Creek, Oconee County, S. C., but locally abundant along foothills of Chattooga Ridge from Brasstown Creek, Oconee County, S. C., to Jackson County, N. C. Separate from *oblongifolia* and *obovalis*, with which confused, by the acuminate leaf blades and long petioles; from *canadensis* by the wolly summit of ovary and longer, narrower ascending or erect calyx lobes.

PYRUS CAROLINENSIS† n. c. On the French Broad River bottoms near Mills River, N. C., occurs this species, which has narrowly ob-

*The following shrubby form can also be mentioned:

A. AUSTRO-MONTANA sp. nov. A shrub not exceeding 4 m. in height. Leaves 2.5-4.5 cm. long, 1.5-3.5 cm. wide, oval and gradually tapering to the apex from the rounded base, or those at tips of twigs, obovate with cuneate base and abruptly acuminate at apex, finely and sharply, but even at tip often rather distantly serrate, with ascending or incurved teeth, the sinus acute, thin, very dark green above, pale green beneath, more or less bronze on unfolding, and coated below with very loose pubescence which has largely disappeared even from the short petioles before foliage is full grown. Flowers, appearing largely before the leaves, in short, nodding 7-10-flowered pubescent racemes, are about 8 mm. long in bud, 15-18 mm. wide when fully expanded, the spatulate petals 2 mm. wide; calyx small 5-6 mm. wide, rather deep, glabrous without, pubescent within around base of style and sparingly on lobes, the tips of which are reflexed after anthesis. Hypanthemum becoming very broad and deep on the glabrous fruit, which is 10-14 mm. thick, shining, nearly black when ripe early in July, the tips only of the erect lobes being recurved, and is born in 4-7-fruited racemes, which are 3-4 cm. long, the lowest pedicel exceptionally 1.5 cm. long. Type from near Brevard, Transylvania County, N. C. Related to *humilis* in fruit characters.

†*Malus carolinensis* Ashe l. c. **14**: 10.

long crenate or obtusely serrate leaves, 7-10 cm. long, and depressed-globose fruit about 1.2 cm. in diameter, green but often with a very ruddy cheek. A variety of it, *P. c. ellipsoidalis*,* has shorter elliptic leaves, serrate only above the middle.

OTHER SPECIES OF PYRUS. In addition to the above and to the two species of crab apple which are mentioned in the Trees of North Carolina, there is a beautiful tree with maple-like leaves (*Pyrus glabrata* (Rhed.) Bail.), which ocurs from Mitchell County, N. C. southward in the mountains. Around Highlands occurs another, *Pyrus elongata* (Rhed.) n. c.,† which has lanceolate, sharply serrate, sometimes lobed, leaves, and small globose fruit often with a red cheek. In the valley of the Tennessee River, in Macon County, occurs *Pyrus platycarpa* (Rhed.) Bail., with elliptic leaves like those of the domestic apple and very large, 10 cm. thick, green pomes. As it is unarmed it has many traits suggesting hybridity with the domestic apple as one parent. Around Asheville two others occur: *P. redolens* n. c.,‡ with oblong crenate leaves and globose green fruit deeply sulcate at apex; and *P. lancifolia* (Rhed.) Bail. with lanceolate unlobed leaves.

SPECIES OF CRATAEGUS. To the large number of red haws which are enumerated might well be added, however, *Crataegus roanensis*, with small bright-red oblong fruit, common in the higher mountains; *C. macrosperma*, with large oblong bright-red fruit, occurring with the preceding; *C. cibilis*, which occurs on the French Broad River near Paint Rock and has scarlet globose fruit 1.8 cm. or more in diameter; *C. brevipedicellata*, having small russet or dull red fruit, frequent in Orange County, and *C. boyntoni buckleyi* (Beadl.)§ n. comb., which is frequent around Asheville. There are about thirty other kinds in the State which become trees.

AESCULUS OCTANDRA PURPURASCENS (Gr.). In the Trees of North Carolina a reference is made to a purple-flowered tree buckeye.

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* *Malus carolinensis ellipsoidalis*, idem.
† *Malus elongata* (Rhed.) Ashe. Bul. Ch. Mus. **12**: 37. 1916.
‡ *Malus redolens* Ashe, l. c. **12**: 39. 1916.
§ *C. buckleyi* Beadl. Bul. Bot. St. 1: 25. 1901.

Dr. Sargent* at one time expressed doubt as to the occurrence of a red-flowered arborescent buckeye in the southern mountains, and he referred to other species, the name which he had applied to such a form. *Ae. hybrida* D. C., in place of being an Appalachian form seems to be a hybrid developed and first propagated in France. But more recently (Trees of Mount Vernon, 1917)† Dr. Sargent notes cultivated reddish-flowered trees, the seed from which they grew having been brought from West Virginia by Washington. A form of *Ae. octandra* quite similar to the description of some of the Mount Vernon trees having flowers variegated with red and purple, has been collected in Ashe and Yancey counties, N. C., as well as in Johnson County, Tenn., about two miles above Mountain City; and a somewhat different form, with the leaves very pale beneath from near the upper edge of the broadleaf forest on the eastern slope of the Blue Ridge, near the Pinnacle, along the Mount Mitchell Railroad.

AESCULUS PAVIA L. the red-flowered buckeye of the coastal plain frequently becomes a small unsymmetrical tree 15 to 20 feet high.

U. S. FOREST SERVICE,
WASHINGTON, D. C.

*T. & S. 2:266. 1913.
†Published by the Mount Vernon Society.

REPORT OF AN INVESTIGATION AS TO CAUSE OF DEATH OF CHICKS IN SHELL IN ARTIFICIAL INCUBATION

By H. B. Arbuckle

In the State of North Carolina it is estimated that over five million eggs are hatched annually in incubators. Of this number, according to figures presented in this paper, over two million eggs with perfectly developed chicks in them are thrown away each year.

At the prevailing price of market eggs this winter this represents a loss of $80,000 in money. When we consider the time, the interference of business, and the high cost of breeding stock, a large per cent of which is brought about by artificial incubation, we are justified in placing the loss at double the figure given. This loss for the United States approaches the astounding figure of $3,000,000.

The author has been interested in poultry raising for over thirty years, and it was his unsatisfactory experience with incubators that led to this investigation, which covers a period of five years.

When it was discovered that the most serious loss in artificial incubation was due to death in the shell after the eighteenth day, provided the conditions generally believed to be essential to a good hatch be kept under proper control, the confines of the problem were greatly reduced.

The loss in artificial incubation was first attributed to unequal temperature. Incubation was conducted at temperatures ranging from one hundred degrees to one hundred and six degrees with slightly varying results in losses. Finally, the temperature factor was removed by using a mercury regulator, which kept the temperature within a quarter of a degree of the desired standard throughout the incubation period.

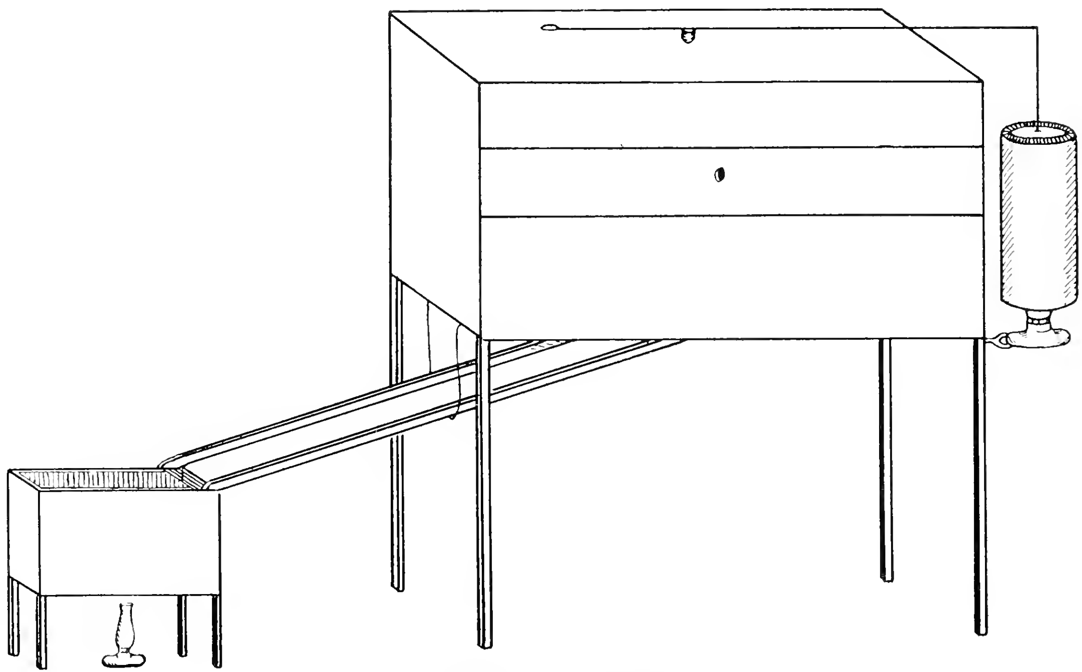
It was next thought to be due to abnormal evaporation on account of incorrect moisture. Experiments led to a very satisfactory determination of proper moisture. A hen was placed on a sitting of

eggs beside the incubator, which was started at the same time. Marked eggs were taken from the hen nest every day and weighed on a chemical balance. The same number of eggs from the incubator were weighed each day. The average loss in weight of fertile eggs from the hen nest at the close of the eighteenth day was found to be 11.4%. The average loss of weight of the fertile eggs taken from the incubator was 18.5%. By proper adjustment of moisture in this particular incubator it was possible to carry through hatches with loss of between 11 and 12%, which we presume must be correct. This adjustment of moisture improved the hatch, but did not cut down the loss in marked degree.

Turning and cooling the eggs were studied with similar results.

A personal experience of the author led to the present attempt to solve the problem. He was in the center of a large auditorium in Atlanta, not noted for good ventilation. The air which he was breathing was coming to him after being used by the great throng on the floor below. After suffering great discomfort he arose to leave the auditorium, and found himself so weak he was scarcely able to walk. The sense of relief experienced when fresh air was reached can never be forgotten. By fortunate coincidence, an incubator was hatching that night, and the author's mind reverted to those little chicks in the shell preparing for the supreme struggle of their lives, when they were by sheer strength to break their way into this world. Certainly if they were seized with the weakness just described they must fail in their struggle and die exhausted. The conditions in the incubator were so similar that on careful deliberation it was believed that lack of oxygen was the principal cause of death. Incorrect moisture might produce great discomfort and be a sufficient reason for good ventilation, but with this exactly right the lack of oxygen might well produce extreme weakness. Animals are supplied with a marvelous nerve mechanism controlled by centers in the brain which speed up or slow down respiration according to the demands of the body for oxygen, but any one who has on a mountain top experienced conditions

PLATE 9



EXPERIMENTAL INCUBATOR.

calling for rapid breathing knows that this wonderful mechanism cannot prevent weakness, which may be due chiefly to lack of needed oxygen.

This led to the investigation, the results of which are presented in this paper.

The author was so convinced of the correctness of his conclusion that he proceeded at once to remove the occasion for the shortage of oxygen, that is, the breathing chick. Before analyzing the air in incubators, he constructed and operated an incubator designed to remove the chicks as rapidly as they were hatched. This incubator is shown in the accompanying figure (Pl. 9).

A light in front of a glass window attracted the chicks toward the front of the egg drawer as soon as they were out of the shell. In their path was a hole cut in the floor of the egg drawer. Falling through this hole and landing on a trap door in the floor of the incubator, supported on delicately adjusted springs, they were emptied out into the chute and soon found themselves in the brooder, where they could breath all the oxygen they needed without robbing their brothers in the eggs above.

The results of these experiments are given in table I (experiments F and G), and show marked improvement over those for the same incubator under normal conditions. Unfortunately, this incubator had a mechanical defect, which was considered important enough to justify abandoning it. Before another was built it was thought more practicable to try the application of oxygen.

The results of the use of oxygen are reported in the table, experiments H, I, J, and K. The author has been handicapped by the limited number of experiments he is compelled to report, because incubators were not accessible, but he feels that the results certainly justify further experimentation.

The analyses of air given in table II point definitely to the fact that there is a shortage of oxygen, beginning early in the eighteenth day and reaching a point below fifteen per cent. Some physiologists believe that animal vigor and health will be rapidly impaired in an atmosphere of low oxygen content.

TABLE I—INCUBATION EXPERIMENTS

	Experiments	Egg Capacity	Eggs Given	Eggs Fertile	Chicks Hatched	Failed to Hatch: Undeveloped	Deformed	Eggs Broken	Matured	Per Cent of Chicks	Per Cent Dead in Shell
Normal incubator hatches four machines	A	120	100	92	40	6	6	------	40	43.5	43.5
	B	120	120	101	52	5	3	------	41	51.8	40.8
	C	150	150	140	66	9	5	------	61	47.1	43.6
	D	60	60	55	22	9	3	------	20	40.0	36.3
	E	240	235	202	115	7	2	2	76	56.9	37.6
Chicks removed	F	120	120	112	84	10	8	------	10	75.2	9.0
	G	120	120	110	80	13	7	------	10	72.7	6.4
Oxygen applied	H	240	210	190	123	53	8	------	36	64.7	18.9
	I	240	230	190	129	7	16	------	38	67.9	20.0
	J	240	220	192	162	------	8	------	22	84.4	15.6
	K	240	200	175	145	11	2	------	17	82.9	9.8
8 hens	L	120	120	105	70	24	2	4	5	66.7	4.8

TABLE II—ANALYSES OF AIR

Experiment	Oxygen Given	Percentage of Oxygen: 17th Day	18th Day	19th Day	20th Day	21st Day
D	None	20.8	20.1	18.2	17.4	16.5
E	None	------------	20.4	19.2	17.8	15.2
C	None	20.7	20.2	18.8	17.2	14.4
H	19th day	20.7	19.2	20.2	20.4	22 8
I	20th day	20.7	19.2	17.2	21.4	24.0
J	18th day	20.8	20.4	20.6	20.4	21.2
K	18th day	20.7	20.4	21.2	21.4	------------

By way of comparison with artificial incubation the results are reported in the case of eight hens, which probably show a record below normal, because one hen by leaving her nest caused a heavy loss, but the very low figures, 4.8%, for loss from death in shell after the eighteenth day, is significant, and probably presents a not unreasonable standard for an incubator operated under perfect conditions.

The tables are self-explanatory. Manifestly they present opportunities for numerous inaccuracies. For instance, it is evident that

all chicks failing to hatch because of some deformity due to abnormal conditions of development could not be certainly determined. Deformities in chicks developed under hens show that these irregularities are not confined to artificial incubation.

As to application, regulation, and cost of oxygen, it was found that oxygen was most conveniently handled in small cylinders, capacity forty gallons of gas. The gas was passed through water, and by counting the bubbles, computing the cubical contents of incubator, and analyzing the air it was found a simple thing to regulate the flow of gas so as to keep the air in the incubator close to normal. Note experiments J and K. The oxygen was introduced in the current of warm air entering the incubator. The quantity required in one case was forty gallons, which cost two dollars, but in another experiment, K, which gave good results, approximately thirty gallons were used. If we take forty per cent as an average figure of loss from death in shell after the eighteenth day, we would in experiment J have secured 107 chicks instead of 162. If the oxygen used was the cause of the 55 additional chicks getting out of the shell, we have a right to say that the two dollars spent for oxygen was a good investment, for this is less than three cents per chick. If they were high-bred stock they would be worth ten times this amount.

One of the interesting features of these experiments with the oxygen-fed incubators was the comfort of the chicks during the last days of the hatch; no crying, no panting, no running about. The absolute quiet was proof that the chicks were enjoying the oxygen.

There seems to be reasonable grounds for believing that lack of oxygen in incubators during the last two days of hatch has much to do with the heavy losses in artificial incubation. Certainly the results reported would justify further investigation by our experiment stations.

Davidson College, N. C.

BRIEF COMPARISON OF THE HERPETOLOGICAL FAUNAS OF NORTH CAROLINA AND VIRGINIA

By C. S. Brimley

The recent list of the Reptiles and Amphibians of Virginia published by Mr. E. R. Dunn (Copeia, Jan. 25, 1918) offers an opportunity for comparing the herpetological fauna of that State with the same fauna of North Carolina. The lists following are based on the above mentioned list with one addition (*Scaphiopus holbrooki,* see Copeia, No. 55), as compared with my list of North Carolina Reptiles and Amphibians (Elisha Mitchell Journal, March, 1915), as corrected to date.

Salamanders.

a. Recorded from both States. Siren, Amphiuma, Hellbender, Marbled Salamander, Spotted Salamander, Tiger Salamander, Redbacked Salamander, Viscid Salamander, Red Triton, Carolina Red Triton, Striped Salamander, Holbrook's Triton, *Desmognathus fusca, D. quadramaculata, D. monticola,* American Newt.

b. Recorded from Virginia only. Hemidactylium scutatum, Plethodon aeneus, Gyrinophilus porophyriticus, Spelerpes longicauda, Ambystoma jeffersonianum.

c. Recorded from North Carolina only. Water Dog, Southern Water Dog, Mole Salamander, Dwarf Salamander, Schenck's Red Triton, Daniels' Triton, *Stereochilus marginatus,* Metcalf Salamander, Sherman Salamander, Yanahlossee Salamander, *Leurognathus marmoratus, Desmognathus o. carolinensis, Des. fusca auriculata.*

Frogs and Toads.

a. Recorded from both States. Common Toad, Fowler's Toad, Solitary Spadefoot, Chorus Frog, Cricket Frog, Common Tree Frog, Peeper, *Hyla squirella,* Bullfrog, Spring Frog, Leopard Frog, Pickerel Frog, Wood Frog, *Rana virgatipes,* Narrow-mouthed Toad.

b. Recorded from Virginia only. Hyla cinera evitta.

c. Recorded from North Carolina only. Hyla cinerea, Hyla femoralis, Dwarf Toad.

Lizards.

a. Recorded from both States. Glass Snake, Fence Lizard, Sand Lizard, Ground Lizard, Bluetailed Lizard.

b. Recorded from North Carolina only. Green Lizard.

Snakes.

a. Recorded from both States. Banded Rattlesnake, Copperhead, Cottonmouth, Water Snake, Willow Snake, Garter Snake, Ribbon Snake, DeKay's

Snake, Redbellied Snake, *Haldea striatula*, *Virginia valeriae*, Worm Snake, Rainbow Snake, Horn Snake, Southern Green Snake, Ring-necked Snake, Black Snake, Black Chicken Snake, Spotted Racer, Black King Snake, Brown King Snake, Milk Snake, Red King Snake, Pine Snake, Spreading Adder.

b. Recorded from Virginia only. Northern Green Snake.

c. Recorded from North Carolina only. Diamond Rattlesnake, Ground Rattlesnake, Coral Snake, Crowned Tantilla, Coachwhip, Striped Chicken Snake, *Rhadinaea flavilata*, Hognosed Snake, *Cemophora coccinea*, *Natrix taxispilota*.

CROCODILES.

a. Recorded from North Carolina only. Alligator.

TURTLES.

a. Recorded from both States. Loggerhead Sea Turtle, Box Turtle, Painted Turtle, Speckled Turtle, Redbellied Terrapin, River Terrapin, Diamondback Terrapin, Musk Turtle, Mud Turtle, Snapping Turtle.

b. Recorded from Virginia only. Geographic Terrapin, LeSueur's Terrapin.

c. Recorded from North Carolina only. Leatherback Sea Turtle, Green Sea Turtle, Kemp's Loggerhead, Yellowbellied Terrapin, Florida Terrapin, Troost's Terrapin, *Clemmys nuchalis*.

SUMMARY

	From both.	*From Va. only.*	*From N. C. only.*
Salamanders	16	5	13
Frogs and toads	15	1	3
Lizards	5	0	1
Snakes	25	1	10
Crocodilians	0	0	1
Turtles	10	2	7
Totals	71	9	35

Of the forms recorded from North Carolina and not from Virginia, seven salamanders and one turtle are forms confined to the mountains, five salamanders, three turtles, and all the additional frogs, lizards, and snakes, as well the one crocodilian, are southern species mainly entering our State from the southeast, the others being three sea turtles and one salamander (water dog) of wide distribution. On the other hand, the forms occurring in Virginia and so far not known within this State are with one exception (*Hyla cinerea evittata*) forms of more northern distribution.

RALEIGH, N. C.

ELIMINATIONS FROM AND ADDITIONS TO THE NORTH CAROLINA LIST OF REPTILES AND AMPHIBIANS

By C. S. Brimley

ELIMINATIONS

1. *Ambystoma jeffersonianum.* Our only record is from Roan Mountain, where S. N. Rhoads collected a number in 1894, but Dunn (Proc. Acad. Nat. Sc., Phila., Jan., 1917, p. 23) states that Rhoads' specimens were not this species, but *Plethodon metcalfi.*

2. *Desmognathus nigra.* According to Dunn (Proc. USNM, Vol. 53, p. 401), the species which has been going under this name is *D. quadramaculata,* while of Rhoads' two specimens from Roan Mountain, one was this latter species and the other *Leurognathus marmoratus.*

3. *Desmognathus ochrophea.* According to Dunn (Proc. USNM, lc, p. 417 *et seq.*), our mountain salamanders of the *ochrophaea* group are not the northern form *ochrophaea*, but a distinct subspecies which he names *D. o. carolinensis.*

4. *Gyrinophilus porphyriticus.* Our only record of adults is from Roan Mountain (Rhoads), but Dunn (Proc. Acad. Nat. Sc., Phila., Jan., 1917, p. 19), who looked over the collections of the Philadelphia Academy of Natural Sciences, where Rhoads' specimens were deposited, records *Gyrinophilus danielsi* from Roan Mountain, but not this form, hence we must discard Rhoads' record, which leaves only the larval record from Black Mountain, which is at least open to doubt as to the correct identification of the specimens.

5. *Chelopus muhlenbergi.* The specimens from Statesville in the National Museum recorded by Yarrow, but now lost, are probably referable to Dunn's new species, *Clemmys nuchalis,* of which he collected specimens at Brevard and Linville.

6. *Deirochelys reticulatus.* Probably not North Carolinian, and therefore dropped till we get positive evidence of its occurrence.

7. *Pseudemys mobilensis.* The specimen from White Lake, referred by me to this species, is probably better referable to *concinna.* I doubt if the two are distinct, anyway.

ADDITIONS

1. *Desmognathus monticola* Dunn (Proc. Biol. Soc. Wash., Vol. 29, p. 73). Described from Brevard, and is what we have been considering the pale form of *D. quadramaculata*, having practically the same distribution in the State.

2. *Desmognathus ochrophaea carolinensis* Dunn. The specimens from the North Carolina mountains referred to *D. ochrophaea* all belong here (see Dunn, Proc. Biol. Soc. Wash., Vol. 29, p. 74).

3. *Desmognathus fusca auriculata Holbrook*. Dunn (Proc. USNM, Vol. 53, p. 413) refers specimens from Wilmington, Beaufort, and Lake Waccamaw here, while I have taken at least one at Raleigh.

4. *Plethodon yonahlossee* Dunn. Described from near Linville (Bull Am. Mus. Nat. Hist., Vol. 37, p. 598 *et seq.*).

5. *Spelerpes montanus* Baird. The common red *Spelerpes* at Raleigh, and apparently in most of the State east of the mountains. Dunn, in a letter of date January 4, 1917, refers to this, specimens from Raleigh, Morganton, Salem, Hillsboro, Beaufort, and Summerville, leaving Raleigh and Goldsboro as the only eastern localities for *ruber*. See Brimley, Proc. Biol. Soc. Wash., 1917, p. 87, and Dunn, Bull. Am. Mus. Nat. Hist., Vol. 37, p. 614.

6. *Clemmys nuchalis* Dunn. Described from Linville; specimens also taken at Brevard. E. R. Dunn, Bull. Am. Nat. Hist., Vol. 37, p. 624.)

RALEIGH, N. C.

A VISIT TO SMITH ISLAND

By W. C. Coker

Smith Island is often referred to but rarely visited by North Carolinians. As a far-flung outpost of subtropical vegetation it is, perhaps, the most unique botannical possession of a State that can exhibit within its borders a range of plant life that would seem quite at home in Florida on the one hand and in Labrador on the other.

The island is not easily accessible and has been visited by few botanists. In Timber Trees and Forests of North Carolina (Bull. No. 6, N. C. Geol. Survey. 1897), by Pinchot and Ashe, there is a fine photograph of palmettos from the island. Mr. Ashe informs me that this photo was made by him and that he knows of no other botanist having visited Smith Island.

On April 5th last I and two of my students, Mr. Couch and Mr. Vogler, went over to the island in a launch from Southport and spent most of the day. We knew, of course, that there were true palmettos there, but were greatly surprised at their vast numbers and large average size. They were everywhere, and as the island is large their numbers must run easily into the fives or tens of thousands. As they stand naturally scattered in the thick forest growth their number does not impress one so forcibly, but in the cleared strips that extend across the island at regular intervals and in which the owner has had the good judgment to leave the palmettoes, they stand in impressive groves, unhidden by other vegetation, and reminding one of the best groves of the Florida coast (Pls. 10, 11, 12). Many of the trees were twenty to twenty-five feet high, and not a few were thirty feet. Unfortunately, many of the palms had been killed and many others injured by the coldest winter in about forty years. About half(?), however, have withstood the shock.

The herbaceous flora was hardly beginning its growth, as the spring had been a cold one, and we found little or nothing in flower among such plants except a few weeds. Besides two ferns (southern polypody, which was common, and ebony spleenwort, which was rare) our records were confined almost entirely to woody plants. An interesting exception was the discovery of the sub-tropical cactus *Opuntia*

PLATE 10

SABAL PALMETTO.
Smith Island, N. C.

Photo. by W. C. C.

PLATE 11

SABAL PALMETTO
Smith Island, N. C.

PLATE 12

SAND DUNES.
Smith Island, N. C.

Photo by W. C. C.

PLATE 13

Photo by W. C. C

OPUNTIA DRUMMONDII.
Smith Island, N. C.

PLATE 14

OPUNTIA DRUMMONDII.
Smith Island, N. C.

Photo by W. C. C.

Drummondii Graham (*O. Pes-Corvi* Le Conte). This species was described from Florida and is given in Small's Botany of the Southern United States as occurring on the coast of Florida and Georgia. It was found by me on the Isle of Palms, S. C., and recorded in my account of the flora of that island (Torrya **5**: 143. 1905). The first, apparently, and, so far as I know, the only* North Carolina record is by Kearney from Ocracoke Island (Contr. U. S. Nat. Herb. **5**: No. 5, pp. 270, 313, 317. 1900).

Of particular interest is the variation in the appearance of this plant when growing under different conditions. It is described as having small, nearly cylindrical joints, and this form we found here, and also on the previous day in exposed sand at Wrightsville. But when growing in rich black sandy loam, protected from the high winds and drifting sand, it may assume a very different appearance, as shown in our plates 13 and 14. The plants shown were in a recent small clearing well back from the shore, and in this rich spot the joints were broad and flat and many times larger than usual. Smaller ones approaching the shore forms were also found in the immediate neighborhood of the large ones, and all intermediate sizes also appeared. As mentioned by Dr. Small, the joints separate very easily from one another and they attach themselves with exasperating readiness and firmness to one's clothing, or anatomy. This Opuntia, called "dildoes" by the negroes of the South Carolina sea-islands, is easily distinguished from the much more common and more widely distributed *Opuntia Opuntia* by the several long slender spines to each areola, the smaller fruit, and usually much smaller and cylindrical joints.

Among the woody plants the most interesting to us were the subtropical evergreen magnolia (*Magnolia grandiflora*) and the mock orange or Carolina laurel-cherry (*Laurocerasus carolinianus*), both of which were scarce and seem to reach here their northern limits in the natural state. They are both highly prized ornamental trees in cultivation throughout the South Atlantic and Gulf States.

*Except in the Journal of the New York Botanical Garden **19**: 71. 1918, where Dr Small says that Dr. R. M. Harper told him "of an observation he made on one of the sea islands of North Carolina, where a number of joints of this small but viciously armed prickly-pear had become firmly attached to the lips of a cow while it was grazing." Dr Small also refers to this Opuntia in two other articles in the same journal, **18**: 237. 1917, and **19**: 1. 1918.

The American olive (*Olea americana*), another fine evergreen tree, was very abundant, and on many were still hanging the ripe, purplish fruits which are very like small olives. Though very fine it is rarely seen in cultivation.

The island is covered thickly, except for the dunes, with arborescent growth of low to medium height. Constituting this growth in the western section, which was the only part examined by us, were the following species of woody plants:

TREES

Loblolly or Old Field Pine (*Pinus Taeda* L.). plentiful in places.
Red Cedar (*Juniperus virginiana* L.), plentiful.
Palmetto (*Sabel Palmetto* (Walt.) R. & S.), abundant.
Live Oak (*Quercus virginiana* Mill.), abundant.
Laurel Oak (*Quercus laurifolia* Michx.), abundant.
American or Wild Olive (*Osmanthus americanus* (L.) B. & H.), abundant.
Yopon (*Ilex vomitoria* Ait.), very abundant.
American Holly (*Ilex opaca* Ait.), rare.
Toothache Tree or Prickly Ash (*Xanthoxylum Clava-Herculis* L.), plentiful.
Smooth Red Bay (*Persea borbonica* (L.) Spreng), abundant.
Flowering Dogwood (*Cornus florida* L.), plentiful.
Red Mulberry (*Morus rubra* L.), not rare.
Hercules Club or Angelica Tree (*Aralia spinosa* L.), plentiful.
Carolina Laurel Cherry (*Laurocerasus carolinianus* (Mill.) Roem.), rare.
Magnolia or Bull Bay (*Magnolia grandiflora* L.), rare.

SHRUBS

St. John's Wort (*Ascyrum hypericoides* L.), plentiful.
French Mulberry (*Callicarpa americana* L.), not rare.
Wax Myrtle (*Myrica cerifera* L.), very abundant.
Groundsell Tree (*Baccharis halimifolia* L.), abundant.
High Bush Huckleberry (*Vaccinium corymbosum* L.), plentiful.
Tall Blackberry (*Rubus nigrabaceus* Bailey?), plentiful.
Dwarf Sumach (*Rhus copallina* L.), plentiful.

VINES

Several species of Smilax (undetermined).
Trumpet Honeysuckle (*Loniceera sempervirens* L.), rare.
Muscadine or Bullace (*Vitis rotundifolia* Michx.), rare.
Virginian Creeper or American Ivy or Woodbine (*Ampelopsis quinquefolia* Michx.), plentiful.
Yellow Jessamine (*Gelsemium sempervirens* Ait.), rare.
Supple-Jack (*Berchemia scandens* Neck.), abundant.
Poison Ivy or Poison Oak (*Rhus toxicodendron* L.), abundant.

PLATE 15

DENDRIUM BUXIFOLIUM.
Brunswick County, N. C.

Photo by W. C. C.

PLATE 16

DENDRIUM BUXIFOLIUM (reduced). Brunswick County, N. C.

Photo by W. C. C.

The larger fungi were hardly appearing as yet, but *Favolus arcularius* was abundant on wood, and in the pure sand of an exposed dune we found a good plant of the mushroom *Volvaria speciosa*. As was to be expected, the *Volvaria* differed from the inland form in some respects, particularly in the larger spores. Although we found no species of the apple group, a few typical galls of the apple-cedar rust (*Gymnosporangium macropus*) were found on the cedar. The spores were probably blown from the mainland several miles away.

I shall not refer here at any length to our observations on the flora of the mainland during this trip, but must include photographs of the very interesting and beautiful little shrub, *Dendrium buxifolium*, which is closely related to the heathers of Europe. This little plant is very local in its distribution and is one of three species of the eastern United States, one of the other two occurring only on the tops of the highest mountains of North Carolina and Tennessee, the other, a species recently (1901) recognized by Dr. Small, is from Table Mountains and a few similar heights in North Carolina and South Carolina. The coastal plant has been reported from the coastal plain of New Jersey to Florida, but seems to have been rarely collected south of New Jersey, as Dr. Small, who has recently monographed the *Ericaceae*, says (N. Am. Flora **29**: 39. 1914) that he has seen no specimens from south of New Jersey.* Along the railroad and the highway from Wilmington to Southport the *Dendrium* is very abundant and grows in close-set colonies over large areas, sometimes as much as an acre in extent. In Plate 15 is shown such a colony in full bloom, and in Plate 16 a single plant. The soil where it grows is sandy and poor and intermediate in elevation and water content between the lower flats (where grow *Azalea atlantica*† and Venus' fly-trap) and the more dry and elevated areas.

While on Smith Island as well as on the return trip to Wilmington by earth road we secured living specimens of many shrubs and a few vines and trees for planting in the University Arboretum.

CHAPEL HILL, N. C.

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*We also have good specimens from Springville, Darlington County, South Carolina.

†An illustrated account of this newly described species will be given in a future number of this Journal.

REVIEW

Professor E. W. Gudger has recently published *A Primer of Household Biology** of decided merit. The book has been reviewed by Dr. James J. Wolfe, of Trinity College—this review having appeared in a folder from the State Normal College. To give this review a wider circulation I take pleasure in reprinting it below. I can heartily recommend the book for use as a text in biology in high schools, and believe it is particularly suitable for girls as a preparation for more intelligent conduct of the home. As indicating still further the cordial reception Dr. Gudger's *Primer* has received, I quote from a letter to Dr. Gudger from Dr. W. T. Sedgwick, of the Massachusetts Institute of Technology, who is a biologist of the highest reputation.

W. C. C.

Dr. Sedgwick says:

"At last I have got around to looking over rather carefully your *Primer of Household Biology*, upon the appearance of which I hasten to congratulate you.

"You have undoubtedly done a good thing—in the first place in drawing attention to the subject and the need of household biology. We have long had household economics, household sanitation, and household bacteriology, and it was high time that we had a household biology.

"Your choice of forms and your treatment in each case seems to me thoroughly scientific and yet practical, and you have made the book a real Biology."

The review by Dr. Wolfe follows:

"A book now issued as a bulletin and modestly styled primer by its author, represents a new departure in the teaching of Biology in this country. Here for the first time so far as the writer knows, have the facts of this science with a bearing on household efficiency been marshaled with a view to welding them into an organized body of knowledge. Twelve years spent in teaching this subject to young women has peculiarly well fitted Dr. Gudger to choose wisely the materials best adapted to this purpose.

"The laboratory work embraces the study of only five types of living things, viz., a green alga, yeast, amoeba, bacteria, and molds. The

*A Primer of Household Biology by E. W. Gudger, Ph.D. Bull. N. C. State Norm. and Ind. Col., Vol. 7, No. 1, pp. 3-103, Sept. 1917. For sale by the College, price 55 cents.

study of types is thus reduced to its lowest terms. Nevertheless, so skillfully and thoroughly are the details derived from these several sources interwoven and tied together that aside from problems of evolution and classification most of the great principles of Biology are well presented. For example, upon the study of a simple, single-celled plant, including experimentation and microscopic examination, is based the fundamental biological concept that in the last analysis the world's supply is dependent absolutely and completely upon the green material of plants. Likewise a single simple animal is used to establish the equally important generality that animals are primarily transformers and liberators of the energy stored by green plants. The limits of this review would hardly permit an epitome of the treatment devoted severally to the yeasts, bacteria, and molds. Suffice it to say that they are handled adequately, clearly, and forcefully, both as to their beneficial and their baneful activities. No person, especially a woman, who puts into practice the information contained in this book can fail to live a healthier, happier, and more efficient life herself, and to contribute immeasurably to the well-being of those dependent upon her ability to make a well-ordered home.

"It is difficult better to express briefly the contribution of the book than to quote its purpose as stated by the author—'to do two things for the students who use it: to give them a sound scientific conception of some of the great fundamental principles of Biology and to drive home to them such a practical knowledge of certain most important living things as will enable them to live healthier and happier lives.' and then to say that in the judgment of the reviewer, and in the slang of the day, he has made good.

"It is a real pleasure to chronicle the appearance of a practical book of such excellence from a neighbor institution, and to say that, in the opinion of the writer, the inclusion of a course in Biology such as is here worked out would contribute strength and depth to any serious study of domestic economy."

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OF THE

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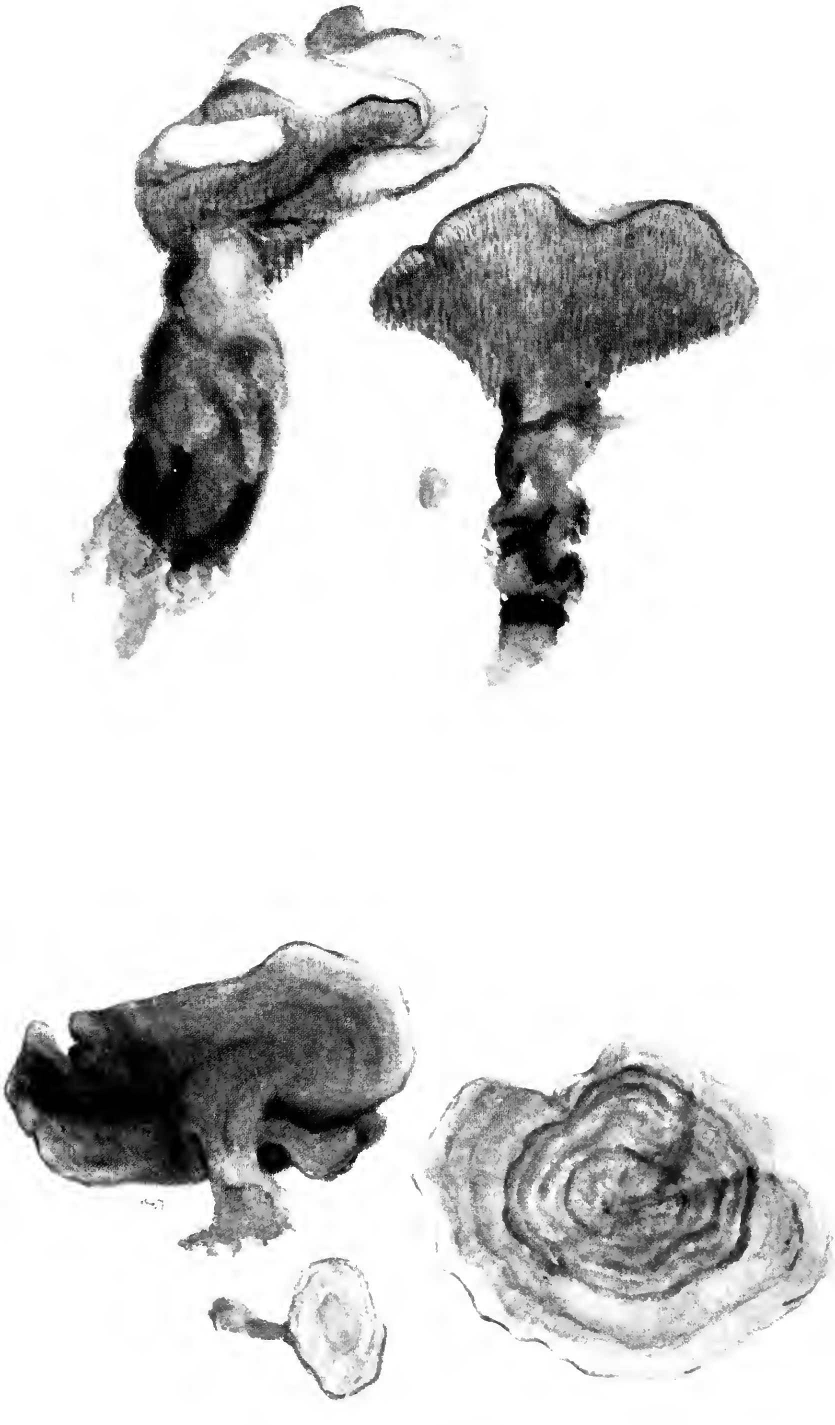
PLATE 1



HYDNELLUM CAROLINIANUM No. 1243 (*Above*)
HYDNELLUM ZONATUM. No. 1238 (*Below*)

JOURNAL

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Volume XXXIV MARCH, 1919 No. 4

INDUSTRIAL APPLICATIONS OF ZIRCONIUM AND ITS COMPOUNDS

By F. P. Venable

PRECIOUS STONES

The earliest use made of a compound of zirconium was that of the natural silicate as a precious stone. It was known under the names zircon, jargon, and hyacinth, and in early times was also supposed to have medicinal value. The use of the name hyacinth among the ancients was confusing as, besides the zircon, it sometimes meant the carbuncle and also a dark amethyst. The zircon, known by lapidaries commonly as the Ceylon zircon or jargon, was regarded as distinct from the hyacinth and was usually colored fire-red, yellow, yellowish-green or gray. The hyacinth was distinguished as oriental hyacinth. Its color was deep red with a touch of brown or sometimes of orange red. Zircons show a great variety of colors from colorless to red, brown, yellow, green, gray, white, pink, and blue, besides intermediate tints. They may be translucent, but ordinarily are opaque.

On account of its hardness (7.5) the zircon is cut with diamond powder or emery. It is cut in the rose, table, or brilliant form. The value depends chiefly upon the purity of the color. On account of its lustre and hardness it has been substituted for the diamond. Indeed, at one time it was supposed to be an inferior variety of diamond. It has been used in jeweling watches and as supports for the knife edges

of fine balances. There is little demand for it at present in jewelry except in the case of fine crystals of pure color. At one time it was supposed to be peculiarly appropriate and was much used in mourning jewelry. Artificial zircons have been more or less successfully produced.

OXY-HYDROGEN LIGHT

The brilliancy of the light given off by zirconia in the oxy-hydrogen flame was first observed by Hare in 1820 in his effort to fuse it. After the development of the Drummond or lime light it was suggested that zirconia be used as a substitute for the lime, offering the advantages of slight absorbing power for carbon dioxide or water. In 1868 du Motay used it in one of the lamps lighting the Tuileries. Napoleon III was so pleased with the result that he ordered its installation in all of the lamps illuminating the court and gardens. The zirconia light attracted much attention on the part of inventors and others. On account of the purity of the light and the high emissive power of the zirconia it was recommended for scientific use, as in polariscopes, spectroscopes, etc., but this more especially refers to the next form.

GAS MANTLES

With the introduction of the Welsbach mantles interest in the Drummond light diminished. The first incandescent mantles made by Welsbach in 1880 consisted essentially of zirconia. Later this was largely substituted by the oxides of thorium and cerium which have a higher emissive power. Zirconia is used in admixture with these and other rare earths.

INCANDESCENT LIGHT

A number of attempts have been made to use metallic zirconium in the form of filaments in incandescent electric lamps. Its electrical conductivity and high fusing point should render it quite suitable for this purpose. Korolkow has made an examination of the electrical resistance, emissive power, and expansion coefficient of zirconium filaments, but such determinations are considerably affected by the presence of even small amounts of impurities. One difficulty which has to be met is the preparation of pure zirconium on a commercial scale and at a reasonable cost. Most of the experiments with zirconium filaments have been carried out with the more or less impure metal, sometimes associated with the carbide which itself has been said to be unsuitable

for the purpose. The properties of zirconium seem to favor its use as a substitute for tungsten should the difficulties in the way of its commercial production be overcome, and its abundance and wide distribution would speedily make it replace the more costly metal. A number of patents have been taken out bearing on the manufacture of the filaments. The use of zirconium hydroxide has been patented for the lining of shells, presumably as containers for gas-forming liquids or solids which might be affected by contact with steel. According to Meyer, investigators who have succeeded in producing malleable zirconium state that it has remarkable properties which fit it for use in the chemical laboratory as a substitute for platinum. So far nothing has been published on this subject.

EXTRACTION OF GOLD

A patent has been granted for the use of ores containing zirconium in extracting gold, platinum, and other noble metals from their ores. The supposition is that zirconium in the metallic state is the active agent.

REDUCTION OF METALS

There is another patent for the use of zirconium, its alloys with magnesium or aluminum, its carbide or phosphide as a means of reducing other metals or forming alloys with them. The reaction is said to be exothermic, and hence proceeds from its own heat after starting.

ALLOYS

Various alloys of zirconium have been formed. The ferro and nickel alloys promise the greater usefulness. Bronzes have also been made. Cobalt, aluminum and magnesium alloys have been placed on the market. Ferro-zirconium has been recommended in steel manufacture for removing oxygen and nitrogen. It has been offered commercially, containing 40 to 90 per cent of zirconium. Small percentages of titanium have also been introduced.

It is claimed that these alloys are not subject to oxidation and are very resistant to chemical reagents. The alloys have a metallic lustre, and some of them take a silvery steel-like polish. They are readily malleable and may find a use as filaments for incandescent lamps. Such filaments are claimed to have the power of selective radiations; in other words, emit more light than corresponds to the temperature at which they are heated by the electric current. This implies a con-

siderably lower wattage per candle-power than is now required by the average metal filament lamp. Analysis of one such alloy shows zirconium, 65 per cent; iron, 26 per cent; titanium, 0.12 per cent; and aluminum, 7.7 per cent. These alloys are produced by reduction with finely divided aluminum together with the mixed oxides of iron, titanium, or whatever metal it is desired to introduce with the alloy. Or they may be produced by heating the mixed oxides in a graphite crucible in an electric furnace using either zircon or zirkelite as a source of zirconium.

For use as a scavenger in casting steel a 20 per cent ferro-zirconium is recommended in an amount equal to 1 per cent of the weight of steel treated.

FURNACE ELECTRODES

Mixed with good conductors zirconia is said to improve furnace electrodes. On account of its low conductivity for both heat and electricity it can also serve as an insulating material. It is further used to replace thorium nitrate for coating the iridium bar and preventing the loss of iridium in the Heraeus furnace.

The oxide, zirconia, possesses physical and chemical properties which make it available for a variety of industrial uses. Among these properties are its high melting point and its low heat conductivity. On account of its low coefficient of expansion it withstands sudden changes of temperature. Its porosity is low so that it is practically impervious to liquids. It is inactive toward most chemicals and scarcely attacked by strong acids or alkaline fusion mixtures. It does not, however, resist the action of hydrofluoric acid and fluorides. Fused bisulphates also act upon it to some extent. It is therefore quite stable in the presence of most fluxes and slags.

As binding material various organic substances, as starch, organic acids, glycerin, tar, etc., have been recommended; also magnesia, phosphates, and borates. Since the native zirconia from Brazil is reasonably pure, it may be used direct with no other than mechanical treatment. Native zirconia begins to fuse at 1,800° C. For use in laboratories and chemical manufacture it is first purified. The chief impurities to be removed are iron, titanium, and silicon.

Working tests show that it has much greater life duration as a lining for furnaces than other refractories. In Germany, experiments were carried out in a closed-hearth steel furnace, and it was found that the zirconia lining was good for eight months use without renewal. This is several times longer than the usual life. Because of the low thermal conductivity the thickness of the lining could be reduced one-half, a two-inch lining being equal to four inches of chamotte. Furthermore, there was a saving of one-half in maintenance costs. In casting molds it shows a high resistance to steel, copper, brass, and bronzes.

It may be used as a protective coating for ordinary fire brick exposed to the action of acids or slags. In such cases sodium silicate serves as a binding material, also air-slaked lime may be added. If it is desirable to increase the porosity and decrease the density, organic substances or volatile salts may be added and burned out in the firing. It is, of course, detrimental to use a binder which may cause softening at comparatively low temperatures.

As a refractory it has also been used in making crucibles, muffles, pyrometer tubes, and for a variety of chemical ware. Combustion tubes made of it are said to be gas-tight up to 1,000° C. Crucibles and combustion tubes of zirconia have been used in the research laboratory of the Royal Berlin Porcelain factory, as they possess great strength and also conduct electricity. They withstand high temperatures and sudden changes. Zirconia crucibles have been used for determining the melting points of pure iron, tungsten alloys, and platinum. Such ware can be plunged in water while red hot without injury.

ENAMELS

Zirconia is also used as an opacifying agent in enamels and a clouding agent in glass as a substitute for the costly stannic oxide and the poisonous compounds of antimony and arsenic. For this purpose it should be quite free from iron, and a number of processes have been worked out and patented. The increasing demand for tin for other purposes and the limited supply may render this substitution necessary. According to some authorities the zirconia has less covering power than stannic oxide. For cheaper ware native zirconia may be used, or ground zircon which

has been treated with hydrochloric acid, then caustic soda, and lastly leached with acidulated water. This would only partially remove the iron present.

GLASS The use of zirconia as a clouding agent for glass has been mentioned above. A thorough comparison with stannic oxide in this application apparently has not been worked out.

The addition of a small amount of zirconia to vitreosil or silica glass is said to increase the tensile strength and resistance to bending or breaking, and to diminish the tendency to devitrification. The temperature at which the ware softens is practically unchanged. The appearance is not improved.

TEXTILE INDUSTRY Zirconium salts, as the hydrated sulphate or the acetate, have been used as a weighting filler for silk. The weight may be increased up to 50 per cent. Stannic salts are ordinarily employed for this purpose.

Various zirconium compounds are also used as mordants in dyeing and in the preparation of lac dyes. Zircon white is used as a pigment, having good covering powers and being unaffected by chemical agents. A patent has also been issued for the preparation of a zirconyl tannate.

COLLOIDAL HYDROXIDE The colloidal properties of the hydroxide have been compared with those of other hydroxides and its use suggested in the purification of water. Also it may find a use as a substitute for sodium tungstate or stannate in rendering cloth non-inflammable.

MEDICINAL As "Kontrastin" it may be substituted for bismuthyl nitrate as a lining substance for the stomach, etc., in X-ray observations and radiographs. It has the advantage of being non-poisonous.

ABRASIVE The carbide has been recommended as a polishing agent, abrasive, and for glass cutting.

CHLORINATING AGENT Willgerodt has suggested the use of the tetrachloride as a chlorinating agent.

CHAPEL HILL, N. C.

THE HYDNUMS OF NORTH CAROLINA

BY W. C. COKER

Fungi with the hymenium borne on distinct spine-like teeth which are typically terete and pointed, and hang vertically. Plant body upright with a distinct stem and cap, or laterally sessile, or the teeth attached to a resupinate stratum; texture varying from fleshy and brittle to tough and pliable. Spores white to brown, smooth or tuberculate or papillate or echinulate. Growing on earth, leaf mold, decaying wood, or injured living trees. Many are edible and none are known to be poisonous. With one exception, the plants here treated include only such as belong to the genera Hydnum and Phaeodon in the sense of Hennings (Engler and Prantl's Pflanzenfamilien. Leipzich. 1900). The family Hydnaceae is now broken up into a large number of genera, including many inconspicuous resupinate plants. In some the teeth are mere knobs or papillæ in others they are more or less flattened or fused and vary towards the Polyporaceae. With the exception of Hydnochaete, all such are here omitted. For special studies of the genera here treated as well as of other smaller and less conspicuous genera of the family, see the following papers by Dr. H. J. Banker:*

A Preliminary Contribution to a Knowledge of the Hydnaceae. Bull. Torr. B. C. **28**:199. 1901.

A Contribution to a Revision of the North American Hydnaceae. Memoirs Torr. B. C. **12**: No. 2. 1906.

Type Studies of the Hydnaceae:

I. *The Genus Manina.* Mycologia **4**:271. 1912.
II. *The Genus Steccherinum.* Mycologia **4**:309. 1912.
III. *The Genus Sarcodon.* Mycologia **5**:12. 1913.
IV. *The Genus Phellodon.* Mycologia **5**:62. 1913.
V. *The Genus Hydnellum.* Mycologia **5**:194. 1913.
VI. *The Genera Creolophus, Echinodontium, Gloiodon, Hydnodon.* Mycologia **5**:293. 1913.
VII. *The Genera Asterodon and Hydnochaete.* Mycologia **6**:231. 1914.

Also see *The Genus Radulum*, by C. G. Lloyd. Cincinnati. May, 1917.

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*Dr. Banker has with great kindness and patience looked over a considerable number of my collections, and I take pleasure in acknowledging his very helpful advice. As I have not always followed his opinion, he must not be thought responsible for any of the errors.

The two plates in color are from paintings by my niece, Gladys Coker; the photographs aro all by me except that of *Phellodon alboniger* which is by Beardslee. All are natural size unless otherwise indicated. The spore drawings are all by me, with a magnification of 2160 They have been inked in by several members of the laboratory staff.

KEY TO THE GENERA

Plants with a distinct cap and more or less central stem; texture fleshy, brittle; growing on the ground ....*Hydnum* (p. 166)
Plants without a distinct cap and stem; soft, fleshy; growing on wood; tuberculate or intricately branched ....*Manina* (p. 176)
Plants with a distinct cap which is laterally sessile or stalked; texture tough, fibrous and dry; growing on wood ....*Steccherinum* (p. 178)
Plants with a stalk and cap; texture spongy or tough (often spongy above and hard below); growing on the ground.
  Spores warted and angular....................*Hydnellum* (p. 181)
  Spores echinulate or papillate.................*Phellodon* (p. 192)
Plants entirely resupinate, the teeth simple or branched, usually flattened; color rusty-cinnamon; texture firm and tough..........................*Hydnochaete* (p. 197)
Plant toughish-gelatinous, watery, translucent, broadened and bent over at the top, the very small teeth hanging from the under side....................*Tremellodon**

In addition to the keys for species under each genus we give below a general key for all the species that are here treated:

KEY TO ALL THE SPECIES HERE STUDIED†

Growing on wood.
  Without a distinct cap, plants large, laterally attached.
    Solid and nearly simple, covered nearly all over with large spines..........................*Manina cordiformis* (1)
    Repeatedly and delicately branched, covered all over with short spines.....................*Manina flagellum* (2)
  With a distinct cap which is attached at the side and strongly tomentose; no stem.
    Color light grayish-brown; flesh dry, fibrous...*Steccherinum Rhois* (2)
    Color light-buff or rosy-buff at maturity; flesh juicy ....*Steccherinum pulcherrimum* (1)
  With a distinct cap, usually with a stem; smooth or very minutely tomentose ....*Steccherinum adustum* (3)
Growing on the ground.
  Having a distinct, strong odor, at least in drying, which is usually of fenugreek, or slippery elm bark, or a more fetid pig-pen odor.
    Very small, up to 1.5 cm. broad...............*Phellodon Ellisianus* (5)
    Over 1.5 cm. broad.
      Taste peppery or sour, odor of fenugreek.
        Taste peppery ....*Hydnellum diabolus* (1)
        Taste sour ....*Phellodon Cokeri* (4)
      Not peppery or sour, spores white, odor fetid.*Phellodon amicus* (1)

*This is not one of the *Hydnaceae*, but is keyed here because of its pendant, awl-like teeth. It will be found under the *Tremellaceae*.
†The numbers refer to the species number under the genus indicated.

No strong odor of fenugreek, etc., and not fetid.
  Color a deep orange salmon on younger parts... *Hydnellum floriforme* (5)
  Color not orange salmon.
    Texture homogeneous, fleshy and soft throughout, size medium to large.
      Cap scaly; stem tapering to a small root.
        Base of stem white.................. *Hydnum Underwoodii* (6), *and Hydnum Murrillii* (8)
        Base of stem greenish................ *Hydnum fuligineo-violaceum* (7)
      Cap scaly; stem not as above........... *Hydnum imbricatum* (3)
      Cap densely tomentose or strigose....... *Hydnum cristatum* (4)
      Cap smooth, pale flesh color............. *Hydnum scabripes* (5)
      Cap smooth, buff color................. *Hydnum repandum* (1)
      Cap smooth, white..................... *Hydnum albomagnum* (2)
      Cap smooth, pale rose.................. *Hydnum roseolus* (9)
      Cap smooth, smoky olive when dry..... *Hydnum fumosus* (10)

    Texture nearly homogeneous, tough, fibrous, flexible when fresh; plants small, cinnamon or chestnut brown when dry.
      Margin pink or white when growing; distinctly zonate.
        Margin usually pinkish when fresh, spores brown, roughly tuberculate.. *Hydnellum zonatum* (4)
        Margin whitish when fresh, spores white, echinulate .... *Phellodon tomentosus* (3)
      Margin not pink or white, scarcely zonate, center with rough asperities, surface felted-tomentose .... *Hydnellum scrobiculatum* (3)
    Texture homogeneous, half-fleshy, toughish; plants rather large, color not as above.... *Hydnellum humidum* (7)
    Texture distinctly duplex, a soft, spongy outer layer and a firm, tough inner layer.
      Hard core of stem and cap black; spores white .... *Phellodon alboniger* (2)
      Hard core of stem and cap not black; spores brown.
        Cap cinnamon brown or umber.
          Cap convex or plane.............. *Hydnellum velutinum* (2)
          Cap depressed to infundibuliform. *Hydnellum Nuttallii**
        Cap buff or tan.
          Plant heavy and compact......... *Hydnellum ferrugipes* (6)
          Plant light and slender........... *Hydnellum carolinianum* (7)

*See foot-note, page 183.

GENUS HYDNUM

Plants with a cap and stem; fleshy; smooth, or scaly; growing on the ground. This includes also the genus Sarcodon, as treated by Banker.

KEY TO THE SPECIES.

Cap scaly, stem tapering to a small root.
  Base of stem white.................................*H. Underwoodii.* (6) *and H. Murrillii* (8)
  Base of stem greenish..............................*H. fuligineo-violaceum* (7)
Cap scaly; stem not as above.........................*H. imbricatum* (3)
Cap densely tomentose or strigose....................*H. cristatum* (4)
Cap smooth, pale flesh color.........................*H. scabripes* (5)
Cap smooth, buff color...............................*H. repandum* (1)
Cap smooth, white....................................*H. albo-magnum* (2)
Cap smooth, pale rose................................*H. roseolus* (9)
Cap smooth, smoky olive when dry.....................*H. fumosus* (10)

1. **Hydnum repandum** L.

PLATES 2 AND 27.

Cap up to 10.5 cm. in diameter, usually convex, uneven and irregular, the margin wavy and often indented nearly to the stem; surface smooth, with the appearance and feel of leather; color a distinct and rather uniform buff, never white. Flesh soft, white, usually brittle, rather thick; odor and taste slight.

Spines soft and fragile, cream color when fresh, turning dark reddish brown in drying, slightly decurrent.

Stem smooth, solid, up to 7.5 cm. long, but generally from 4-6.5 cm. long and about 1.3 cm. broad at top, usually enlarged considerably at base; color a light creamy buff.

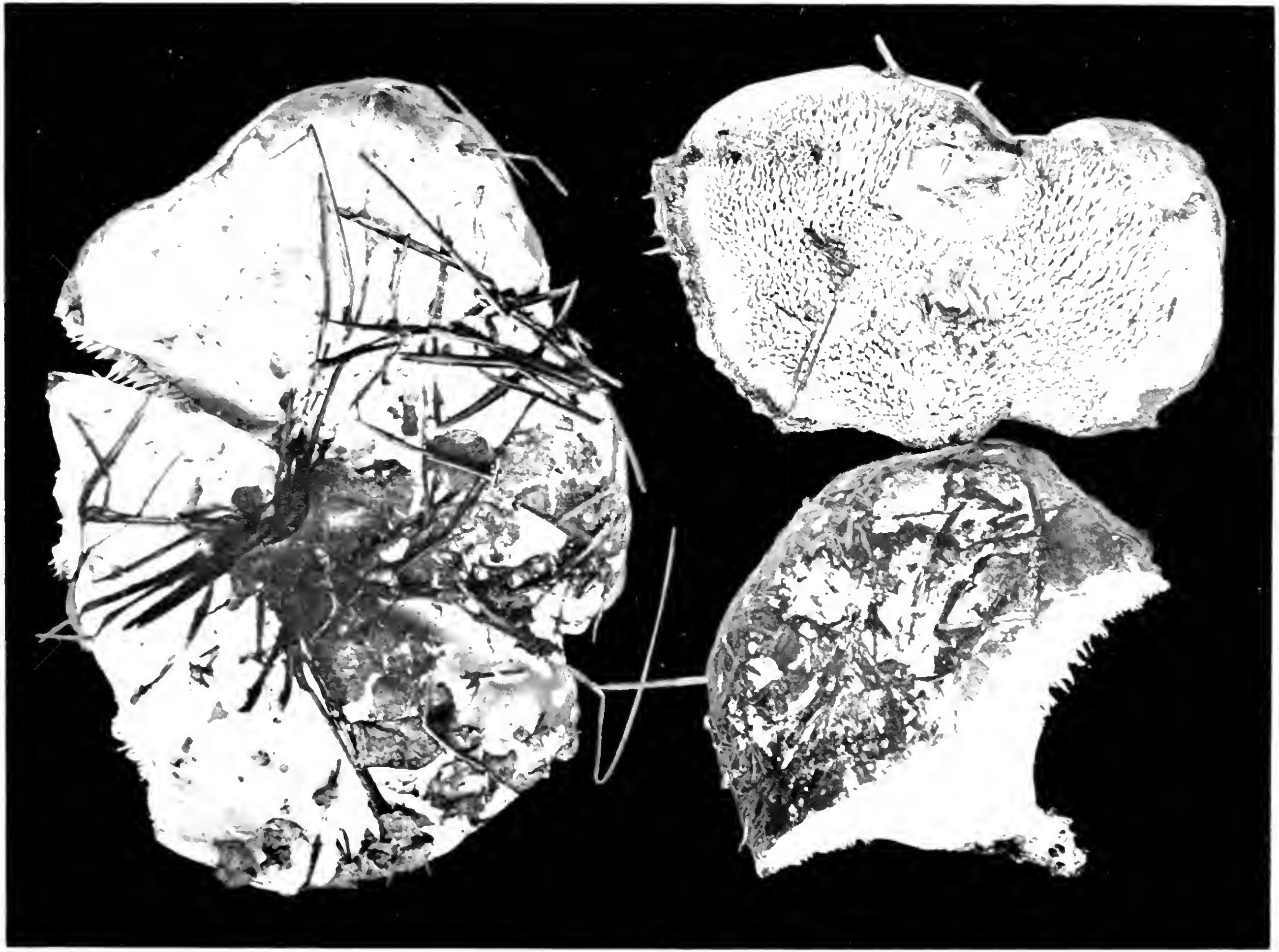
Spores (of No. 603) white, smooth, subglobose, 6.3-7.4 x 7-8μ.

This is a firm and attractive species and considered excellent for food. It is not uncommon in mixed woods. It may be easily distinguished from *H. albo-magnum*, its nearest relative, by the white color, elliptic spores and pine-woods habitat of the latter. Banker does not regard our plant as exactly typical *H. repandum*, but they do not seem to differ from Bulliard's good figures (Pl. 172). For other good illustrations see Gibson, Our Edible Toadstools and Mushrooms, Pl. 27; and Taylor, Food Products I, frontispiece.

PLATE 2

HYDNUM REPANDUM. No. 895

PLATE 3



HYDNUM ALBO-MAGNUM. No. 991

288. Mixed woods, Battle's Park, September 25, 1910. Spores about 7.5μ in diameter.
289. Ravine east of Tenny's, mossy earth, September 24, 1905.
348. Battle's Park, near branch, October 2, 1911.
527. Woods northeast of schoolhouse, October 9, 1912.
603. Near branch back of athletic field, October 21, 1912.
848. Woods by Howell's Branch, September 26, 1913. Photo. Spores spherical, white, $5.5\text{-}7.4\mu$ in diameter.
895. Battle's Park, east of Dr. Battle's, October 8, 1913. Photo.
1278. In mixed woods near the branch southeast of athletic field, September 28, 1914.
1452. Woods south of cemetery, October 29, 1914.

Montreat, rich woods, near mountain brook, July 6, 1915. Coker.
Blowing Rock. Atkinson.
Common in woods. Curtis.

2. **Hydnum albo-magnum** Banker

PLATES 3 AND 27.

Cap up to 11 cm. broad, more or less wavy, the center usually depressed and margin lobed, surface smoothish or minutely velvety in places, adhering to trash when young, but this seems due to the surface layer growing around and into the trash rather than to viscidity, as each twig and pine leaf is lying in a little trough and there is no noticeable viscidity at maturity even when soaked; color pure white or creamy in places, not changing color when rubbed. Flesh up to 1.4 cm. thick, abruptly narrowed to the thin margin which scarcely extends beyond the spines. It is pure white, solid, but rather soft and fragile, taste sweetish and quite pleasant, odor faintly aromatic. The upper 2 or 3 mm. of the flesh, which cannot be distinguished from the rest when not soaked, will immediately imbibe a large amount of water and become clear and translucent, in sharp contrast to the non-bibulous opaque white part beneath.

Spines up to 5 mm. long towards center, shortening towards margin, but the long ones also having much shorter ones mixed among them. They are slender, sharp pointed, about 1/3-1/2 mm. thick at base, fragile and easily breaking away from the cap, only slightly decurrent.

Stem short, central or eccentric, expanding above into the cap, pointed below, about 1.5 cm. thick in middle; texture solid and

scarcely firmer than that of the cap, surface white or cream, smoothish, the apex dotted with the fading spines.

Spores ovate-elliptic, smooth, white, 4-4.4 x 6-6.8μ.

This plant is new to North Carolina and has not, in fact, been found before outside the type locality in Alabama. It is a good species, easily distinct from *H. repandum*.

1991. Oak and pine woods south of old schoolhouse, November 21, 1915. Photo.

3. **Hydnum imbricatum** L.

Sarcodon imbricatus (L.) Karst.

PLATES 4 AND 27.

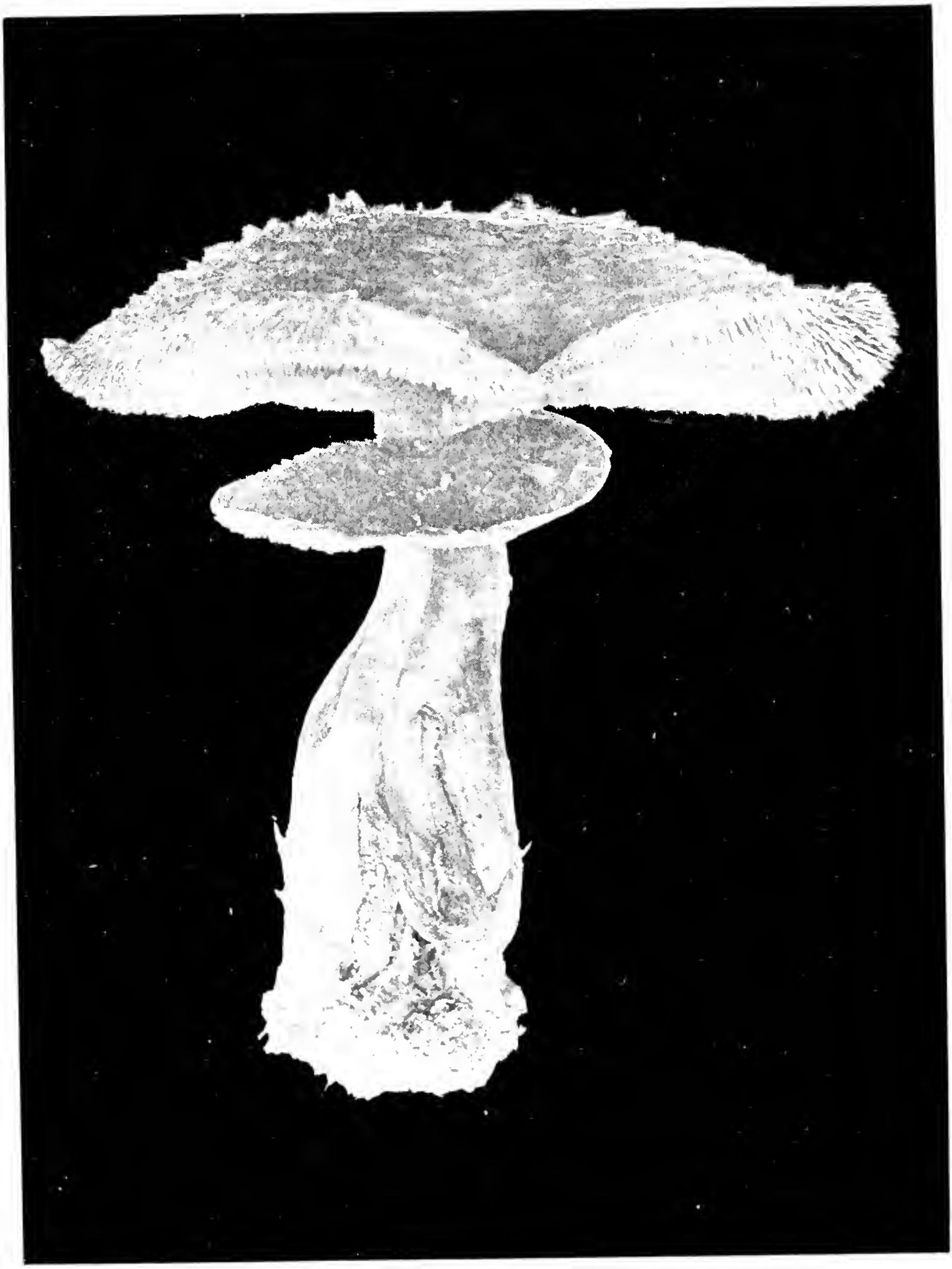
This is our largest terrestrial Hydnum, the cap reaching a width of 22 cm. It grows from the ground on a distinct stem, is single or sometimes cespitose, and may be distinguished by its scaly cap and deep smoky-brown or umber color. Cap expanded from a central or eccentric stem, irregular, strongly imbricate-scaly as a rule, with the margin thin and lobed (usually) and with smaller scales; color a deep brown, often blackish in drying. Flesh soft, but toughish and pliable, pale brownish, thin except in center.

Stem usually short for the size of the plant, about 3-6 cm. long, and 1.5-3.5 cm. thick, rarely up to 9 cm. long: surface irregular, smooth below, marked at top by the descending spines, color like that of cap or lighter.

Spines color of the cap, about 1 cm. long, shortening towards the margin, which they almost reach.

The species is not uncommon in deciduous woods in summer and fall. It reaches a much larger size than allowed by Banker for the plants he describes under *H. imbricatum*, and he is inclined to believe that there are several distinct forms now passing under that name. Lloyd thinks (Myc. Notes **40**:552. 1916) that most, at least, of the records of *H. imbricatum* in America are really for *H. adpressum* or *H. subsquamosum*. But our Chapel Hill plant is just like his figure of *H. imbricatum* (fig. 758) and varies into forms having other names. Figures of the European plant, such as Krombh., Pl. 49, and Schaeff., Pl. 140, could easily be substituted for ours. I feel sure that we have

PLATE 4



HYDNUM IMBRICATUM. No. 413

but one species of this type at Chapel Hill, and I think it best to refer it to *H. imbricatum*. The scales may become very dark on a little exposure. Again they may be represented only by inherent mottlings except in the very center, and such plants (as our No. 1525) could as well be referred to *H. laevigatum*. All gradations are found between. *Hydnum laevigatum* has been listed from North Carolina by Schweinitz, Curtis, and Memminger. As understood in America, the species seems to differ from *H. imbricatum* only in its nearly smooth cap, the center more or less scaly. As all gradations occur between this condition and the typically scaly cap of the latter we do not know how to separate them. *Hydnum subsquamosum* has also been reported from this state by Curtis and by Memminger (MS. notes) but seems equally elusive and uncertain in its characters.*

291. Oak woods, top of Lone Pine Hill, September 14, 1910.
413. Near path from west gate of campus, south of Dr. Battle's, October 31, 1911.
467. Woods on hill south of branch, Battle's Park, September 30, 1912.
525. Woods east of schoolhouse, October 9, 1912. Scales inherent except in very center.
841. Woods east of Tenny's, September 26, 1913.
1182. Mixed dry woods south of athletic field, July 20, 1914.

Arden, September, 1915, sent by Mrs. I. M. Jervey. Size 21.5 x 18 cm. (U. N. C. Herb. No. 2016).

Middle and upper districts, earth in woods. Curtis.

4. **Hydnum cristatum** Bres.

Sarcodon cristatus (Bres.) Banker

This species, the type of which was collected at Blowing Rock by Atkinson, is reported by Banker from several Northern States. We

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**Hydnum canum* Schw. was described from this State. Of it Banker says: "The specimen in the Schweinitz herbarium throws little light on this species as it is a mere fragment and suggests a tough coriaceous plant rather than a fleshy one. Fries treated the species as a synonym of *H. gracile* and Schweinitz himself expressed doubt as to the validity of the species." The original description is as follows (Syn. Fung. Car. 77. 1818):

"H. cinereo-albidum, pileo carnoso glabro, subulis et stipite longis. Passim in abruptis muscosis. Magnitudo Hydni subsquamosi, uncialis et triuncialis."

Hydnum Curtisii Berkeley, described from South Carolina, is of doubtful validity. The original description is as follows (Grevillea 1:71. 1872):

"Fuligineo-fuscum; pileo orbiculari laevi; margine inflexo; stipite centrali sursum attenuato; aculeis elongatis acutis integris. No. 2809. Car. Inf.

"Whole plant of a dingy brown; pileus $\frac{3}{4}$ inch across, even; margin inflexed; stem bulbous at the base, where it is nearly $\frac{1}{2}$ an inch thick, attenuated upwards; spines even, entire, elongated. Allied to *H. laevigatum*."

have not found it and take the following from Banker (Memoirs T. B. C. **12** : No. 2, p. 140. 1906):

"Plants terrestrial, mesopodous, yellowish, 6-10 cm. high; pileus convex to subplane, more or less uneven, irregular, 3-10 cm. wide; margin subrepand, sterile; surface densely velvety tomentose to strigose hairy, in the latter case the hairs forming more or less anastomosing ridges or crests, the hairs usually branching, disc often floccose, color tan or ochre yellow, at margin lighter to whitish; substance fleshy to somewhat tough, pale brown; stem stout, solid, subcylindrical or tapering somewhat to the base, subvelutinus or with spine-like crests of strigose hairs, tawny, 1-5 cm. long by 1-2 cm. wide; teeth slender, terete, even, obtuse, decurrent, tawny olive to fuscous becoming dark brown with whitish tips in drying, '3-6 mm. long,' when dried 2-3 mm. long by 0.1-0.3 mm. wide, 2 or 3 to one millimeter; spores subglobose, tuberculate with small warts, 4-5μ wide, 'tawny olive on paper'; taste acrid. Ground in mixed woods. Aug.-Sept."

5. **Hydnum scabripes** Pk.

Sarcodon scabripes (Pk.) Banker

PLATES 5, 6, AND 27.

Large, irregular, fleshy plants with eccentric stems. Cap up to 14 cm. wide, convex, depressed in center, quite irregular and excentrically expanded, surface smooth, leathery, a pale flesh color. Flesh pallid white, but turning brownish-flesh color when cut, soft, tender and with a mild pleasant taste, about 2 cm. thick at stem, the margin very thin, free and extending about 3 mm. beyond the teeth as in *H. imbricatum*, sharply bent down.

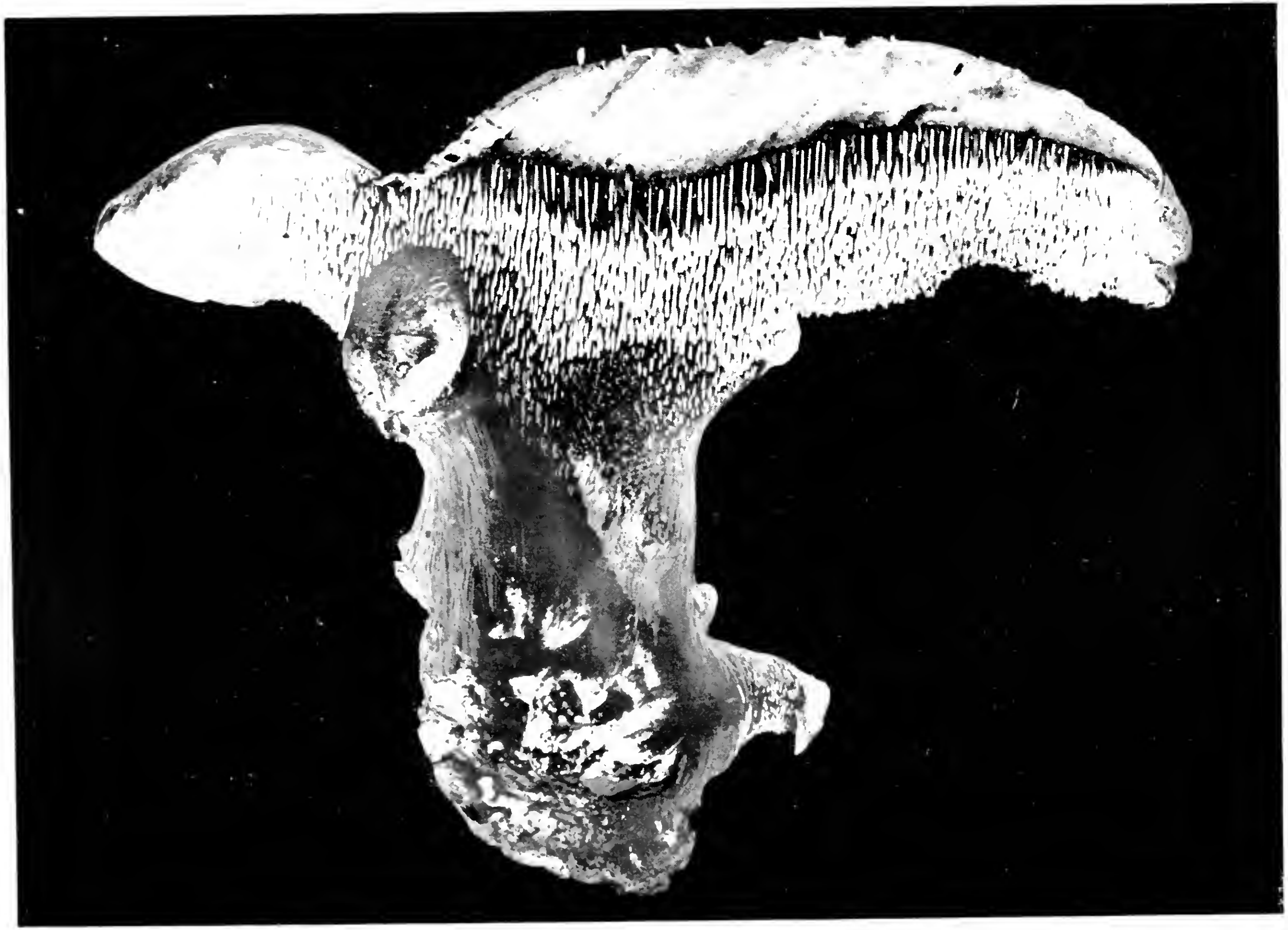
Spines whitish at first then deep snuff brown, except for the ashy-white tips, irregularly decurrent. They are about 8 mm. long near the stem, shorter towards the margin, the tips rather bluntly rounded.

Stem eccentric, heavy, thick, about 4-6 cm. long, and 2.5-3 cm. thick, enlarged and bent at the base and frequently giving rise there to small secondary, aborted plants, surface smooth except where marked by the descending spines which extend down the stem on some sides and not on others, often becoming so short as to be mere dots.

PLATE 5

HYDNUM SCABRIPES. No. 1836

PLATE 6



HYDNUM SCABRIPES. No. 1836

Flesh solid, firmer and shorter than that of cap, light grayish-brown, turning deeper flesh brown when cut.

Spores a dull brown, about avellaneous of Ridgway, roughly isodiometric, star-shaped and other irregular forms from the large tuberculate warts, 6.3-7.2 x 6.3-8.1μ.

This large and interesting species is new to the South, having been known before only from New York. It is at once distinguished from *H. imbricatum* by the smooth, leathery surface of a pale flesh color, and by the very different spores.

1836. In rather dry soil, pine and oak woods south of Piney Prospect, September 20, 1915. Photo and drawing of spores.

6. **Hydnum Underwoodii** (Banker)

Sarcodon fennicus Karst. ?

PLATES 7 AND 27.

Cap up to 6.5 cm. wide, slightly convex or nearly plane, somewhat depressed in center when mature, rather wavy and irregular, the margin often indented; surface dry, covered all over with rather small low scales or the margin merely floccose or nearly smooth; apparently less scaly in youth; color vinaceous brown, about fawn; margin very thin, free for about 1-2 mm. and bent under. Flesh white, about 4-5 mm. thick near stem, firm, fleshy, elastic, bitter.

Spines nearly white when young, soon a clear brown except for the ashy-white tips. They are quite fine and short, only 1-2 mm. long, sharply pointed, very decurrent, usually almost to the base of the stem, becoming shorter downwards to mere granules below. When dry they are very brittle and easily fall away, and become a uniform brown, about snuff brown to sudan brown.

Stem 3.5-7 cm. long, about 8-10 mm. thick near center, sometimes swollen and fistulose, always quite crooked, usually strongly bent at the ground, expanding into the cap above, tapering downward, and continuing to taper more rapidly in the ground to a sharply pointed root, deep snuff brown, the rooting base abruptly pure white; flesh firm, toughish, elastic, brownish.

Spores (of No. 1837) dusky brown, about avellaneous of Ridgway, roughly spherical with large tubercles giving star and other fantastic shapes; one oil drop, 5.5-6.5 x 6.3-7.8μ.

A very distinct species easily recognized by its peculiar, pointed brown stem with its white root, deeply decurrent spines, and vinaceous-brown, scaly cap. It is new to the South, having been heretofore recorded only from New Jersey and Connecticut. With us it occurs rather rarely in moist deciduous or mixed woods.

Banker has seen our plants and refers them to his *S. Underwoodii* with which they agree well, and they are like the type plants at the New York Botanical Garden and others so determined by Banker. Specimens at the New York Botanical Garden of *H. fennicum* from Italy determined by Bresadola have the same pointed base and surface of cap, but the spines darker, shorter, and decidedly stouter in proportion to length than in our plants described above, in which the teeth are very slender. The spores are smaller than in ours, being about 4.5-5.5 x 5-6.5μ. Other good plants at the New York Botanical Garden from Italy, determined by Bresadola as *H. fuligineo-violaceum*, cannot be distinguished in the dried state from his *H. fennicum* plants just mentioned, except by the still smaller spores which average only about 4.7μ in diameter. Both of these differ distinctly from a good plant of *S. fennicus* from Karsten himself (Finland) which has very delicate slender teeth of a lighter brown color just as in our *H. Underwoodii*. The spores of this specimen seem immature and stick together and to the spines. They are apparently about 5μ in diameter. It would seem that *H. Underwoodii* is the same or very near *H. fennicum* as understood by Karston except for the smaller spores of the latter, while *H. fuligineo-violaceum* as interpreted by Bresadola is a different plant with stouter, shorter, more abruptly pointed teeth which tend to curl in a hook-like manner in drying, and with still smaller spores. Kalchbrenner's fig. (Pl. 32, fig. 2) of *H. fuligineo-violaceum* shows color with little or no violet in it, even in the flesh. The size, shape and abruptly pointed base are very like our plant.*

*American plants determined by Banker as *S. fuligineo-violaceus* (Mem. Tor. B. C. **12**, No. 2, 142. 1906) have since been referred by him to a new species, *S. radicatus* (Mycologia **5**:13. 1913).

PLATE 7

HYDNUM UNDERWOODII. Nos. 1829 AND 1837

1829. Rocky soil by path in woods north of Meeting of the Waters, September 19, 1915. Photo with 1837.

1837. In mixed woods just across the branch from Indian Spring, Battle's Park. September 20, 1915. Photo.

1858. On ground in hardwoods, by Battle's branch, near Strowd's pasture. September 22, 1915.

Asheville. Beardslee.

7. **Hydnum fuligineo-violaceum** Kalch.

Beardslee finds plants at Asheville that are larger than our *H. Underwoodii* and that have a greenish base. They have been referred by Bresadola to *H. fuligineo-violaceum*, and as Beardslee thinks them different from *H. Underwoodii* it seems best to follow Bresadola. In the dried state Beardslee's plants are very like ours and I can make out no difference in the spores. Plants from Bresadola at the New York Botanical Garden, determined by him as *H. fuligineo-violaceum*. (see discussion under *H. Underwoodii*) do not seem to me to be just like the Asheville plants. Beardslee's description follows:

"Pileus 5-12 cm. broad, convex, becoming depressed at the center, and irregularly lobed on the margin, brown or tan, sometimes with a shade of dull red, surface floccose, soon breaking up into small, rather narrow scales; margin thin, fertile, inflexed and irregular. Taste bitter; odor rather strong and not agreeable.

"Teeth small, short, crowded, gray, with the tips white, decurrent.

"Stem rather long, attenuate downward, rough above with rudimentary teeth, white tomentose at the base, which is pointed and becomes dark green within.

"Spores subglobose, 6-7μ, tuberculate.

"I find this everywhere in our woods. Some forms are smaller than the typical forms and seem to present differences. All that I find have the short, crowded teeth, the bitter taste and usually the greenish color at the base of the stipe. I cannot distinguish more than the one species. My plants have been submitted to Bresadola who refers them as above, but says that they vary toward *H. Fennicum*. This is not the plant which Banker refers to *H. fuligineo-violaceum*." * In a letter of March 17, Beardslee says further: "In my studies of it I have found two forms, one small like yours, and another

*See foot-note on page 172.

larger and rougher, of which I sent you photos and specimens. My feeling is that while your plant can be referred to Banker's species my larger one cannot. It does not dry to a translucent mass, the flesh is far from being 'less than 1 mm. thick when dry,' and the stipe in my plants is always a peculiar green at the base."

8. **Hydnum Murrilli** (Banker)

This species is represented at the New York Botanical Garden by an ample type collection (Murrill and House No. 397) from the mountains of North Carolina. I have examined the plants and find them very near *H. Underwoodii* with the same short, fine teeth; but most of the plants are more infundibuliform than is our *H. Underwoodii* and the color of the dried plant is more yellowish. Further comparison in the fresh state are needed. The original description by Banker follows (Mycologia **5**:15. 1913):

"Hymenophore terrestrial, mesopodous, medium to large size, reddish-brown; pileus expanded to infundibuliform, subrotund to irregular, 5-10 cm. wide, 1-2 mm. thick when dried; surface roughened with fine floccose scales, coarsest toward center, 1-2 mm. wide, ends upturned, about as long as wide, subzonately arranged, dark-reddish brown on scales, lighter between; margin thin, fertile, repand, finely lobed or crenate, pallid; substance fleshy, pale-brown to whitish, drying thin, but somewhat tough and flexible; stem subcentral, strongly inclined, tapering gradually and then abruptly to the base, reddish-brown above, concolorous with pileus, paler below but becoming blackish at the base, scabrous roughened nearly to the base, apparently hollow or stuffed, 4-6 cm. long, 1-2 cm. wide; teeth small, slender, terete, tapering, acute, crowded, decurrent nearly to the base, reddish-brown, white tipped, 1.5 mm. or less long in dried plant, 0.15-0.25 mm. wide, 9-12 to a square mm.; spores subglobose, tuberculate, tubercles not prominent, pale-brownish, 6-7μ wide; basidia prominent, irregular, clavate, 8-10μ wide; sterigmata conical, curved, horn-shaped, 3-4μ long; hyphae of trama hyaline, smooth, thin-walled, collapsing when dried, recovering in KOH, subparallel but partly separable in KOH, septate, without clamp-connections, segments

short, stout, constricted at the septa, irregular, 10-28μ wide by 20-70μ long; hyphae of the teeth very slender, tubular, rarely septate, 3-4μ wide."

9. **Hydnum roseolus** (Banker)

The following species, found by Murrill and House in the mountains of North Carolina and known from no other station, is described by Banker. I have been through the *Hydnums* in the New York Botanical Garden, but have not been able to find any part of the type (M. and H. 392) on which the species is based. The following is the original description (Mycologia **5**:16. 1913):

"Hymenophore terrestrial, mesopodous, gregarious, small to medium size, 4-6 cm. high, pale-rose-color; pileus plane to convex, 3-4 cm. wide, 0.5 cm. or less thick; surface pubescent and slightly imbricate, scaly, even, whitish tinged with old-rose; margin thin, incurved when dried; substance fleshy-tough, drying into two layers, an inner waxy and gummy, subtranslucent layer, and an outer dry, opaque, subfibrous layer; stem slender, subcentral, strongly inclined, subeven, slightly radicating, scabrous, 2-3 cm. long by 7-10 mm. wide; teeth very short, terete, tapering, acute, uniform, decurrent and abortive on the stem, not crowded, 0.3-0.7 mm. long by 0.1-0.2 mm. wide, 16-20 to a square mm.; spores pale-brown, tuberculate, ovoid, 4-5 x 5-6μ wide; basidia clavate, four-spored, 5-6μ wide; sterigmata slender, capillary, 3μ long; hyphae of inner portion of pileus clouded, smooth, slender, thin-walled, collapsing when dried, recovering in water and KOH, forming a somewhat intricate and compact tangle, scarcely separable in KOH, septate, without clamp-connections, segments long, irregular, subtubular, 4-7μ wide, contents granular; hyphae of outer portion of pileus more even, tubular, and coiled."

10. **Hydnum fumosum** (Banker)

This species, known only from the mountains of North Carolina, is evidently quite different from any other American *Hydnum*. The type collection is in the New York Botanical Garden (Murrill and House, No. 391). The description by Banker follows (Mycologia **5**:16. 1913):

"Hymenophore terrestrial, mesopodous, small, 3-5 cm. high, ash-gray to smoky; pileus plane to convex, 2-3 cm. wide, 2-3 mm. thick; surface even, subpubescent, ash-gray to smoky-olivaceous-brown when dried; margin thin, fertile, minutely serrate; substance fleshy-spongy when fresh, somewhat tough, flexible, compact, subwaxy toward surface, soft fibrous within, olivaceous when dried; stem slender, subcentral, inclined or curved, attenuate upward, subpubescent at base to glabrous shining toward the cap, 2-4 cm. long, 3-10 mm. wide; teeth short, slender, terete, tapering, acute, uneven, not decurrent, pale to dirty-white, somewhat crowded, 2-5 mm. long or less, 0.2-0.4 mm. wide, 9-12 to a square mm; spores dark, coarsely and densely tuberculate, ovoid, 7-9μ x 9-11μ wide; basidia clavate to oblong, narrowing abruptly at the base, 7-10μ wide by 25-30μ long; sterigmata delicate, conical, incurved, 3-4μ long; hyphae of trama colored, dissolving out freely in KOH, becoming hyaline, slender, smooth, thin-walled, collapsing when dried, recovering slightly in KOH, forming an intricate tangle but slightly separable in KOH, septate without clamp-connections, segments extremely long, somewhat irregular, more or less constricted at the septa, 4-6μ wide; hyphae of the teeth very slender, parallel, 3-4μ wide; taste bitterish."

GENUS MANINA.

Plants without cap and stem, solid and tuberculate or intricately branched; teeth long, hanging from most of the body; texture fleshy and soft; growing on wood.

KEY TO THE SPECIES.

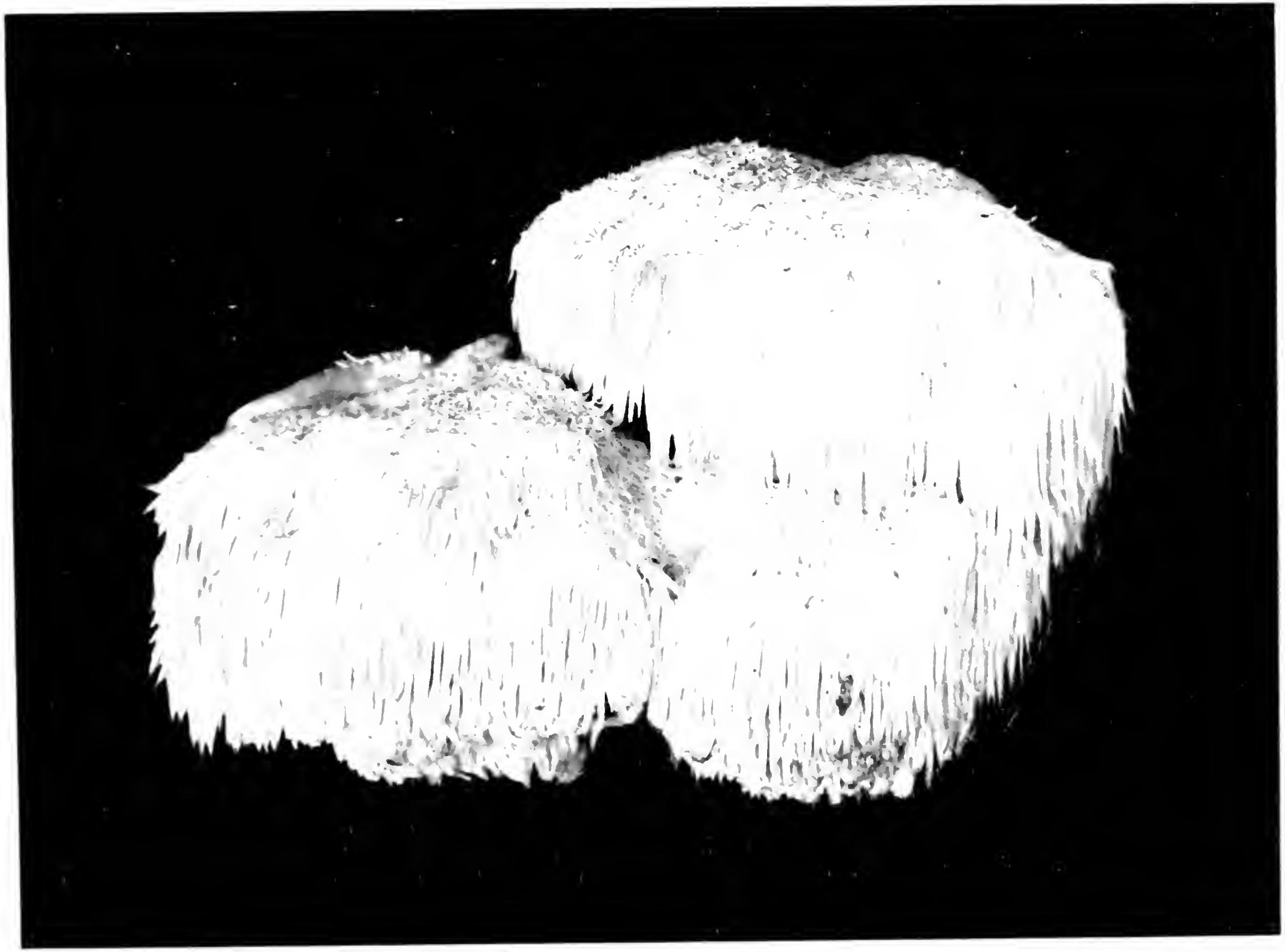
Solid and nearly simple............................*M. cordiformis* (1)
Repeatedly branched ....*M. flagellum* (2)

1. **Manina cordiformis** Scop. Satyr's beard Hydnum.
Hydnum erinaceum Bull.

PLATES 8 AND 27.

This is our largest species of the family and it is rather common on rotting places in living deciduous trees in fall, mostly on oak, rarely on beech. It is also occasional on dead trees. It does not branch in

PLATE 8



MANINA CORDIFORMIS. No. 1296 Reduced

a complex manner like the coral Hydnum, but forms a heavy, solid mass that is covered with long, fleshy, parallel, pendant spines. It projects laterally from a narrowed point of attachment and requires several weeks to attain its full size, which is often several pounds in weight. The color is creamy-white or yellowish and it turns brown on drying. The spores are smooth or perhaps very minutely rough, spherical to subelliptic, 4.8 x 5.5μ, or when spherical about 5μ in diameter.

This species is said to be very variable, but in Chapel Hill it is unusually constant in its appearance. Only one of our collections (No. 295) varied in shape towards the form called *M. caput-ursi*. It is easily distinguished from *M. flagellum* both in form and in the larger spores. Edible.

295. On wood in Battle's Park, October 28, 1910.
526. At base of a small oak tree in woods east of schoolhouse, October 8, 1912.
627. Rotting place in beech tree near Battle's Branch back of Dr. Wilson's, October, 1912.
988. On dead place in a live tree, Battle's Park, near Piney Prospect, October 16, 1913.
1277. On a dead place on an oak, southwest of athletic field, September 28, 1914. Photo. Spores subelliptic to spherical.
1296. At base of a dead oak, south of cemetery. Spores white, spherical to subspherical, smooth, one large oil drop, 5.1-5.9 x 5.1-6.4μ.
1249. On rotting log in woods south of athletic field, October 14, 1914.
1250. On dead oak log in woods east of Graded School, October 15, 1914.
1401. On a dead, but rather solid oak log, 1/8 mile below Meeting of the Waters, October 21, 1914.

Asheville. Beardslee.
Common, base of trunks. Curtis.

2. **Manina flagellum** Scop.

Hydnum ramosum Bull.

PLATES 9, 10, AND 27.

When fresh and perfect this is one of the most beautiful of fungi and is a picture of exquisite delicacy. It grows from dead wood in an intricately branching mass up to about 12 cm. wide, pure white throughout and extremely fragile. The whole surface

is covered with innumerable, short, glistening-white, pendant spines about 5.8 mm. long. Spores (of No. 1447) spherical to subelliptic, smooth, pure white, clear, one oil drop; 3.7-4.6 x 4.4-5.3μ. Edible.

This species may be distinguished from all others by its much branched character, its delicacy and snowy whiteness, and by the distribution of the spines over the entire plant. This is certainly the form that passes under the name given above (see Banker, in Mycologia **4**:276. 1912). It is probable that the *M. coralloides* is nothing more than another growth form of this. It is certainly distinct from all forms of *M. cordiformis* which has a solid, bulky body and larger spores.

296. Battle's Park on a dead log, October 3, 1910.
1447. On dead log just below woods road, south of cemetery, October 29, 1914. Photo.
1984. On a dead hickory about 10 feet from the ground, Battle's Park, November 12, 1915.

Blowing Rock. Atkinson.
Common, side of trunks. Curtis.

GENUS STECCHERINUM.

Plants with distinct cap, which is usually laterally sessile or more or less distinctly stalked, occasionally partly resupinate; texture tough and fibrous; growing on wood.

KEY TO THE SPECIES.

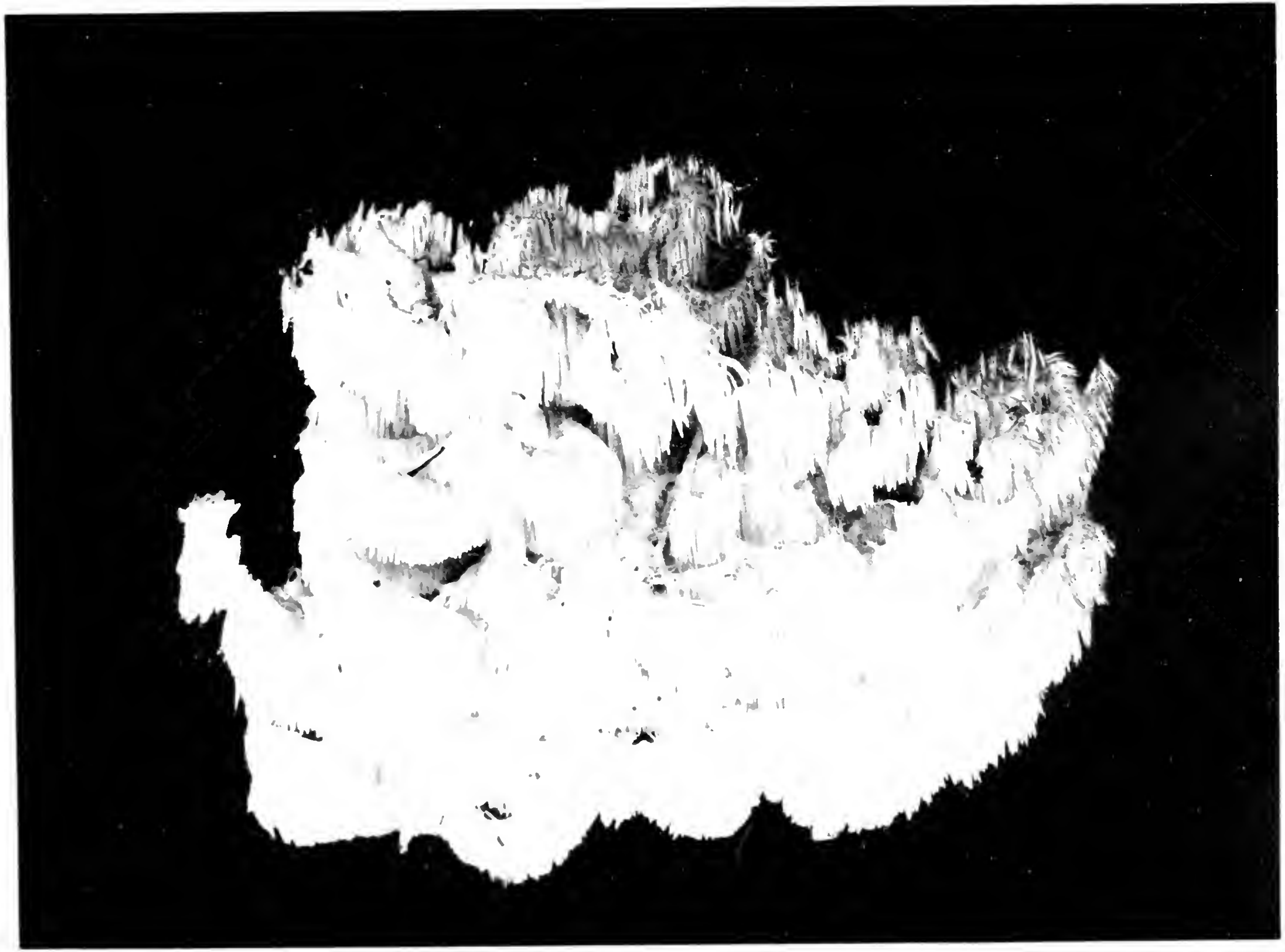
Cap strongly tomentose.
Color light grayish-brown; flesh dry............*S. Rhois* (2)
Color light buff at maturity; flesh juicy.........*S. pulcherrimum* (1)
Cap smooth or very minutely tomentose.............*S. adustum* (3)

1. **Steccherinum pulcherrimum** (B. & C.) Banker

PLATE 11.

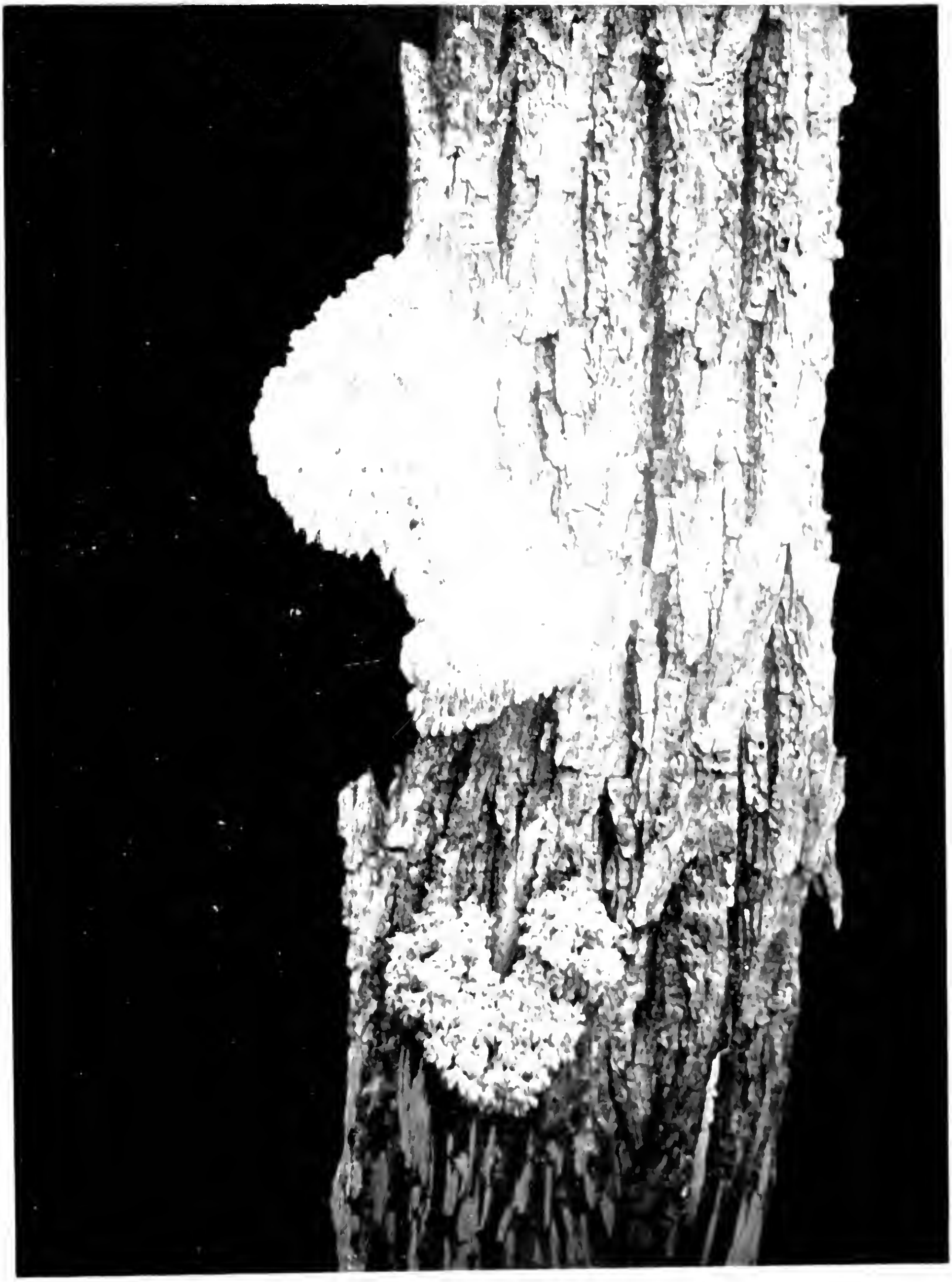
Caps expanded, horizontal, imbricated and partly confluent, entirely sessile from a resupinate base; individual caps about 4 cm. wide, 2-2.5 cm. thick at base, quickly thinning towards the margin. Surface densely fibrous, whitish when young, turning light buff or rosy buff. Flesh white, fibrous, tough, elastic and fleshy, 1.5-2 mm. thick at base, about 4 mm. thick near the rather blunt margin, almost

PLATE 9



MANINA FLAGELLUM. No. 1117

PLATE 10



MANINA FLAGELLUM No. 1984 Reduced

tasteless, but with a faint odor resembling that of preserved figs; when dry it is very soft, light and fibrous and if wet and pressed between the fingers it has a gummy feel.

Spines dense, crowded, slender, 2.5 mm. long at base, 1 mm. long near margin, whitish then light pinkish-buff, extending downward on the resupinate portion.

Spores said by Banker to be oblong, smooth, granular, hyalin, 2-2.5 x 4.5-5μ, very transparent with one or more dark granules.

A plant very like the above was sent to Fries by Curtis and named by the former *Hydnum friabile*. Lloyd thinks he has recognized the latter species in a plant sent to him from New York (*Letter* 65, p. 7). From his description of the flesh, which is of the same nature as that of *Polyporus sulphureus*, our plant is not that species, as in the latter the plant is composed of very loosely woven parallel fibers and is not mealy. Also see Lloyd's *Letter* 65, p. 10, for comparison of *H. pulcherrimum and H. septentrionale*. Banker thinks *S. friabile* and *S. pulcherrimum* the same (Mycologia 5:294. 1913).

1254. On a rotting oak stump in grove back of President's house, September 24, 1914. Two photos. No spores obtainable.

2. **Steccherinum Rhois** (Schw.) Banker

PLATES 12 AND 27.

Plants elastic, tough, shell or kidney-shaped, sessile by a constricted base, sometimes confluent, up to 3.5 cm. by 2 cm. in size; surface densely felted—hairy, the felt collapsed in places, distinctly zonate, color a rather light grayish brown with zones of different shades, the marginal half somewhat darker; margin sterile for about ½ mm. The color and appearance is so like that of the lighter shaded plants of *Lenzites betulina* as to be indistinguishable in passing. Context of two distinct parts, a dense, firm, elastic layer, which is about ½ mm. thick and colored like the teeth, and a soft, densely felted upper layer, colored like the surface and varying from less than ½ to as much as 1.5 mm. in thickness.

Spines ochraceous tawny (Ridgway), crowded, short (1-1.5 cm. long), tapering somewhat towards the tip, but truncate and more or less blunt at the ends, which are fimbriated on their margins and

sometimes over the entire surface. In section, as shown by the truncated tips, the teeth are irregular and more or less angular, varying considerably in size and often several fusing.

Spores (of No. 1511) white, oblong-elliptic, smooth, clear, minute, 1.8 x 3-3.8μ.

Growing on dead wood of deciduous trees.

87. On a stump, meadow at foot of Lone Pine Hill, October 14, 1911.
1511. On fallen branch of white oak in Professor Howell's yard, December 10, 1914. Photo.

Common, stumps and sticks. Curtis.

3. **Steccherinum adustum** (Schw.) Banker

PLATES 13 AND 28.

Plants growing on logs, sessile or stalked, at times resupinate in part, simple or complicated by others springing from the back of the lower ones near the point of attachment. Cap up to 8 cm. wide, roughened and uneven with low ridges and channels and sometimes with nodules, minutely velvety, or smooth in places, white or faintly tinted with creamy-flesh or light tan, smoky when rubbed and often dark on the margin; circular or fan-shaped, the margin very thin and wavy. Flesh pure white, tough and elastic, 2 mm. thick near center, tasteless and odorless.

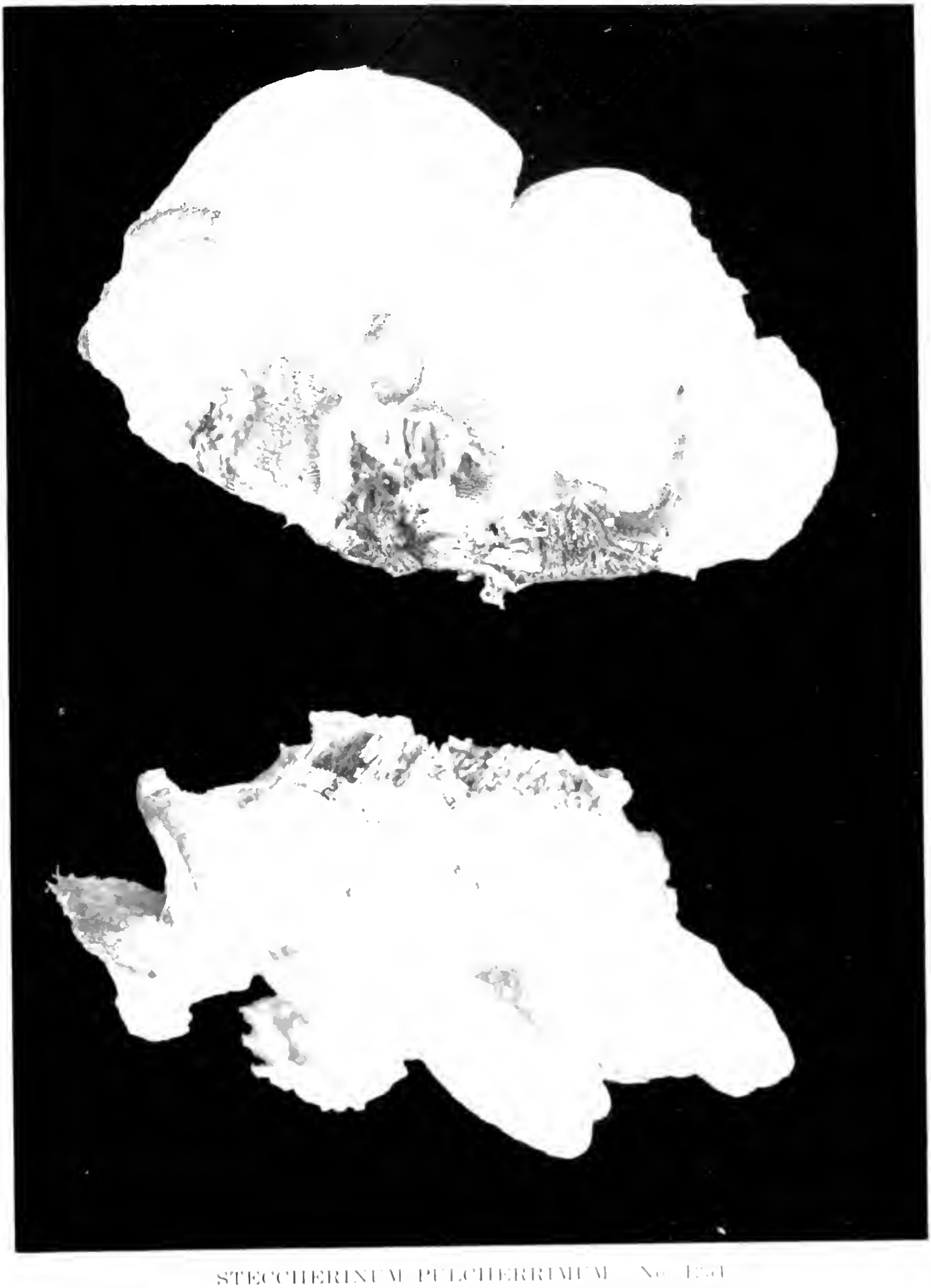
Stem entirely absent with the cap laterally attached, or with a short but distinct stem which is eccentric or lateral or rarely central. It is up to 1 cm. long and very variable in size, velvety, white or discolored.

Teeth about 1.5-3.5 mm. long, more or less flattened, and *generally branching near the tips into several processes,* white at first, then turning quickly when drying to a clear and beautiful rose color, then purplish rose, and in age a dark cinnamon-brown. If bruised when fresh the teeth turn to a deep smoky color due to the fact that they are covered with minute hairs, visible only under the microscope, and these hairs when bruised turn almost black.

Spores (of No. 1607) white, long-elliptic, smooth, minute, 1 x 3μ.

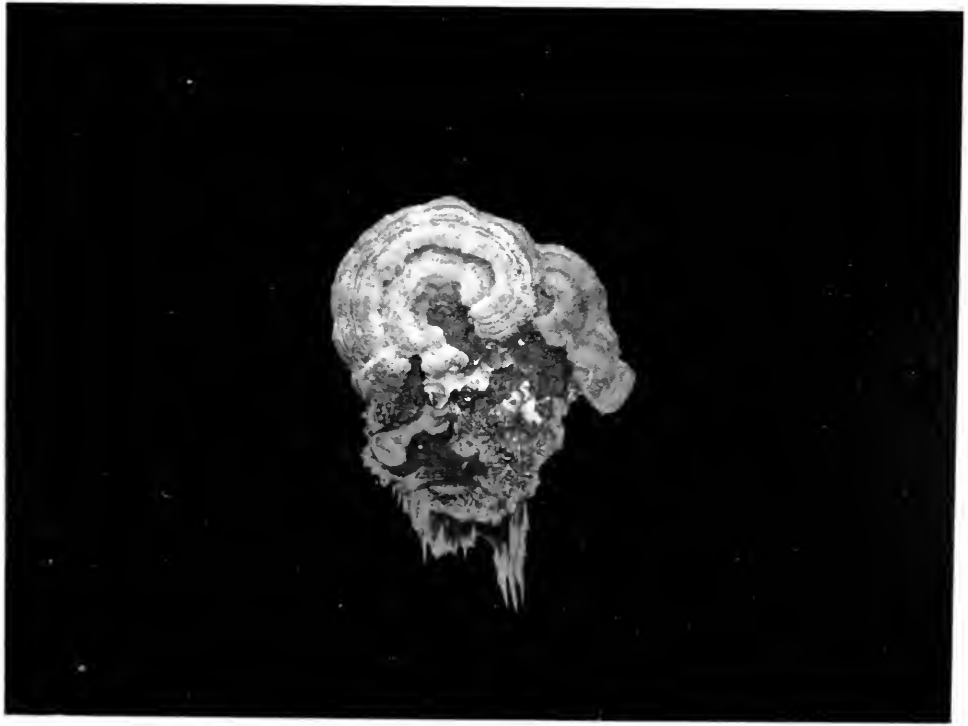
Growing on rotting wood.

PLATE 11



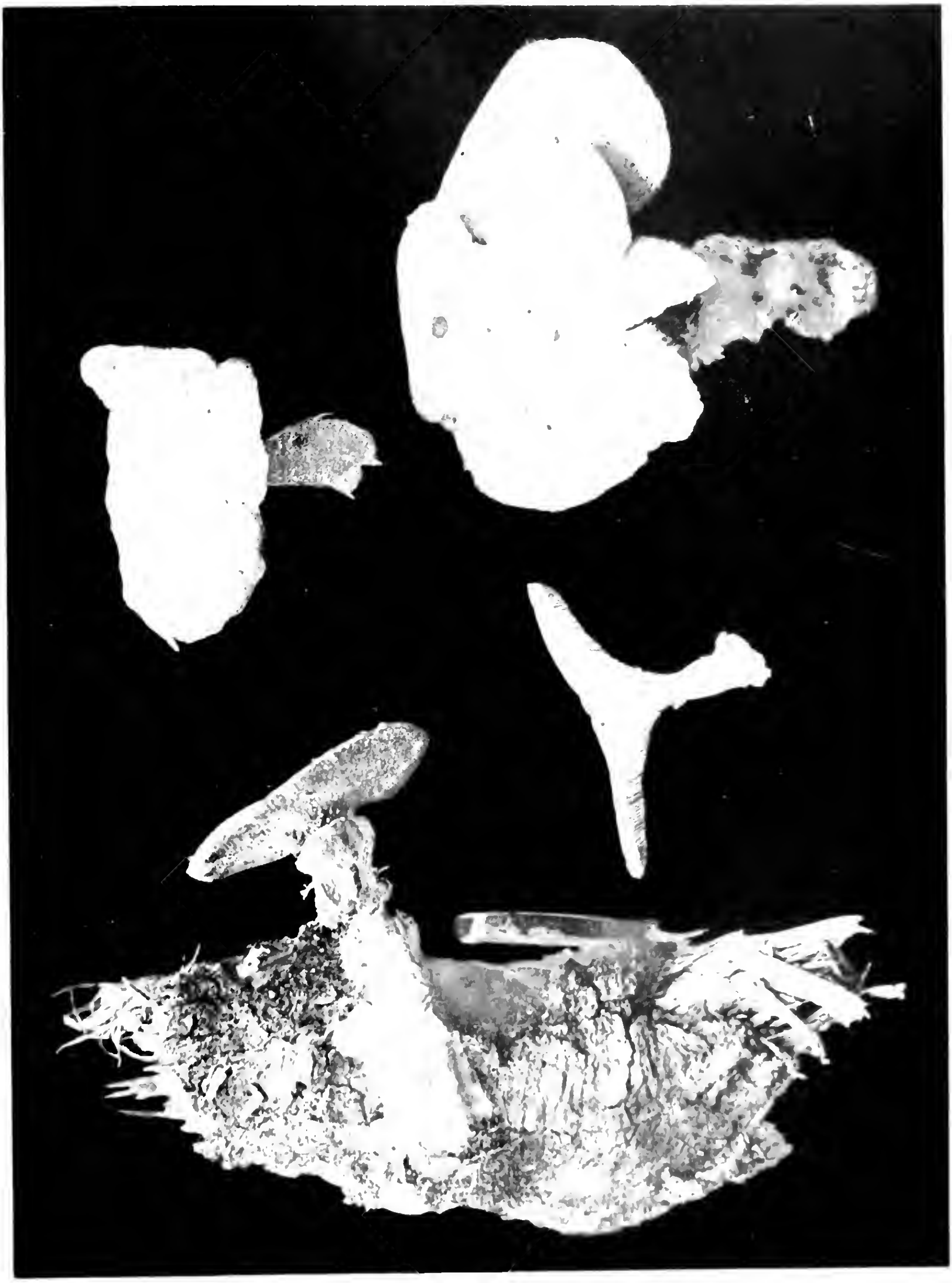
STECCHERINUM PULCHERRIMUM No. 1254

PLATE 12



STECCHERINUM RHOIS. No. 1511

PLATE 13



STECCHERINUM ADUSTUM N [illegible]

86. On a dead oak limb behind athletic field, October 20, 1911.
293. Woods near Chapel Hill.
350. At base of stump, Battle's Park, October 8, 1911.
1219. On dead oak branches, swamp of New Hope below Durham bridge. July 27, 1914. Photos.
1235. On rotting wood by branch above Meeting of the Waters, September 21, 1914.
1607. On rotting wood in three clumps, two below Strowd's Spring, the other above Durham bridge, June 23, 1915.
2012. On stump by street near Dr. Herty's, November, 1915.
2243. On a deciduous log, swamp of New Hope Creek, below Durham bridge, June 24, 1916.
2313. On rotting wood near mouth of Tenny's Ravine, June 29, 1916.

Middle and upper districts, on sticks. Curtis.

GENUS HYDNELLUM.

Plants with cap and stem, but often deformed or fused; texture tough, in some species thin and homogeneous, in others thick and composed of two layers of different texture; spores unevenly tuberculate. Growing on the ground. The genus cannot be distinguished from *Phellodon*, except by the spores, and this is by no means easy even for experienced students.

KEY TO THE SPECIES.

Flesh thin, homogeneous, tough and flexible when fresh; plants small to medium.
- Cap strongly zonate, thin, margin pale and often pinkish .... *H. zonatum* (4)
- Cap scarcely zonate, less thin, margin not whitish .... *H. scrobiculatum* (3)

Flesh rather thin, homogeneous, fleshy-tough and flexible; plants usually large.................... *H. humidum* (8)

Flesh thick and of two textures, soft and spongy above hard below.
- Color a deep orange-salmon, at least on younger parts .... *H. floriforme* (5)
- Color not as above.
  - Taste peppery, odor of fenugreek............ *H. diabolus* (1)
  - Taste not peppery.
    - Cap creamy buff, the center becoming brown.
      - Plant compact and heavy................ *H. ferrugipes* (6)
      - Plant light and slender................. *H. carolinianum* (7)
    - Cap cinnamon brown, plane or convex, the margin pale when growing.............. *H. velutinum* (2)
    - Cap grayish umber, depressed or infundibuliform .... *H. Nuttallii**

*See foot note on page 183.

1. **Hydnellum diabolus** Banker

PLATES 14, 15, AND 28.

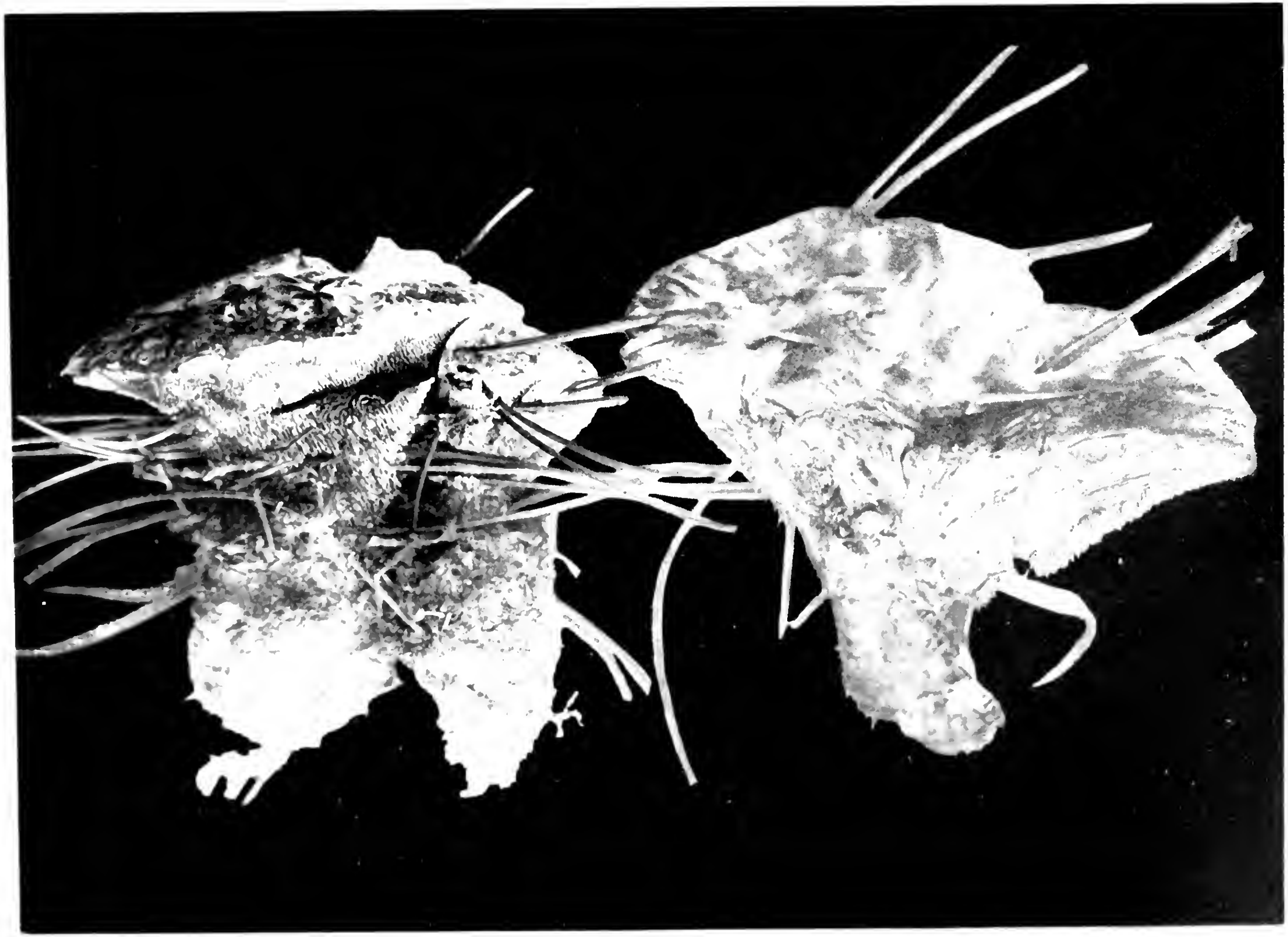
Plants short and stout, gregarious and often confluent. Rather common on ground in pine woods, particularly in autumn.

Caps up to 15 cm. broad, flat, sometimes nearly smooth, but usually with low waves and protuberances, and irregular on the margin; soft and minutely tomentose-felted all over. Color a pretty, light salmon-flesh tint when young and fresh, or often nearly pure white on margin, changing from center outward to a vinaceous-rust color (almost sorghum brown of Ridgway) with blackish stains where rubbed, particularly on the margin, in age becoming a deep sordid brown from center outwards. Flesh thick in center, distinctly zonate, blunt on margin, about color of cap but when quite fresh turning blackish instantly when cut; quite soft near the upper surface, and gradually getting firmer towards the spines. The watery juice of our plants is not reddish but colorless, but Underwood found plants of *H. diabolus* in Alabama with very red juice, and the species is described by Banker as having a red juice, but Banker now considers the juice color as of little or no taxonomic importance (see Mycologia **5**:197. 1913). The odor is pleasant and aromatic (fenugreek) when fresh, but this often disappears in drying. Taste quite peppery. All parts of the plant tend to become blackish when bruised.

Spines very short near the margin, 4.5 mm. long near the stem, somewhat decurrent, color of cap on margin, turning through light vinaceous salmon to russet vinaceous then sorghum brown and finally to a deep chestnut brown.

Stem short, stout, irregular and dropsical in appearance, deep russet brown even when young, 1.5-2.5 cm. long and often as thick as long, flesh at upper end like that of cap, becoming harder and darker at bottom. No distinct superficial layer, but the surface is soft, the flesh gradually hardening inwards. The texture of the plant is much like that of *P. amicus*, except that the soft surface layer is not so distinct from the firmer inner part as in that species.

PLATE 14



HYDNELLUM DIABOLUS No 1341

PLATE 15

HYDNELLUM DIABOLUS No. [illegible]

Spores (of No. 1341) light vinaceous brown: roughly spherical to elliptic, strongly angular, a large oil drop, 3.7-4.3 x 4-5μ. For the original description of this species see Mycologia **5**:194. 1913.

1341. In pine woods by path leading to Meeting of the Waters from road east of cemetery, October 14, 1914.

1869. Growing in Battle's Park, near branch, in pine woods, September 22, 1915.

1951. Under *Pinus inops* on hillside north of King's milldam, October 31, 1915. Photo. Exactly like 1341. Odor of fenugreek, taste strongly peppery. One plant 15 cm. in diameter.

1968. Growing in pines by a woods road near Mason farm, November 7, 1915.

2. **Hydnellum velutinum** Fr.*

Hydnum spongiosipes Pk.

PLATES 16 AND 28.

Cap about 3-7.5 cm. broad, often confluent with others, convex or plane, or often slightly depressed in center, usually irregular in shape with the surface more or less grooved, pitted and complicated by eruptions, but without the rough and harshly complicated centers of *H. scrobiculatum,* without zones or with a few faint zones of shades; surface finely tomentose, plush-like when young and also in age unless too much wet or handled; color after maturity cinnamon brown all over with a lighter sheen from the surface tomentum when quite fresh, blackish-brown when bruised, the margin not lighter except when wet; when quite young the cap tomentum is nearly white, and the margin remains whitish (very light fleshy-brown) as long as it is growing, the older central part soon becoming dark. Flesh of two textures, a soft spongy upper layer about 1-6 mm. thick, colored like the surface, and a thin, darker, tough, and much harder lower layer; when fresh the flesh is full of a clear watery juice which in our plants is not at all pink; taste and odor not strong, hardly disagreeable, somewhat like rotting wood, when young and fresh faintly like ripe cucumbers, no fenugreek or pig-pen odor.

*HYDNELLUM NUTTALLII Banker.

A plant collected by Atkinson in the mountains of North Carolina is referred to this species by Banker, who says that it "differs in some respects from the type but in characters that seem to be accounted for by the fact that the plant was old and dead when collected." We have not seen the plant, but the species is said to differ from *H. velutinum* in the form of the pileus, in the subrugose not tomentose surface and in the [illegible] teeth. For the full description, see Memoirs Torr. Bot. Club **12**, No. 2: 155. 1906.

Spines sharp, slender, rather crowded, about 3 mm. long, shorter at stem and fading away towards the sterile margin, slightly decurrent, light brown on the margin, deep cinnamon brown elsewhere, darker when bruised; when still growing the marginal ones are the color of the cap margin.

Stem central, short or of moderate length, 1.4-3.5 cm. long, 8-13 mm. thick at cap, much thickened below by an irregular surface mass of spongy tissue which surrounds and binds surrounding trash, and is often confluent with adjoining plants; surface colored like the cap and of the same plush-like tomentum; flesh hard inside, soft and spongy towards the surface.

Spores (of No. 2401) brown, roughly globose and tuberculate, 4-6μ. See drawing.

These are thought by Banker to be the same as *H. velutinum* Fr., and after careful examination of a plant from Italy (Bresadola) in the New York Botanical Garden I quite agree with him. The appearance is the same, and the spores are identical. See drawings.

1367. Mixed woods on hillside near branch, about 30 yards below Judge's Spring, October 14, 1914. Odor slight, woody.

1606. On ground among leaves under a hickory tree just north of Piney Prospect. Spores subspherical, coarsely tuberculate, about 5-5.5μ, exactly like the spores of 2401. This is much like *H. diabolis* except that the taste is not peppery but slightly acid with a woody flavor, juice watery.

2401. Low place in mixed pine and deciduous woods, near Meeting of the Waters, July 20, 1916. Photo.

2412. Pine and deciduous woods near Battle's Branch, July 22, 1916.

2424. Under pines mixed with oaks near the top of Lone Pine Hill, July 26, 1916. Spores subspherical, coarsely tuberculate, about 5μ in diameter, just like those of No. 2401.

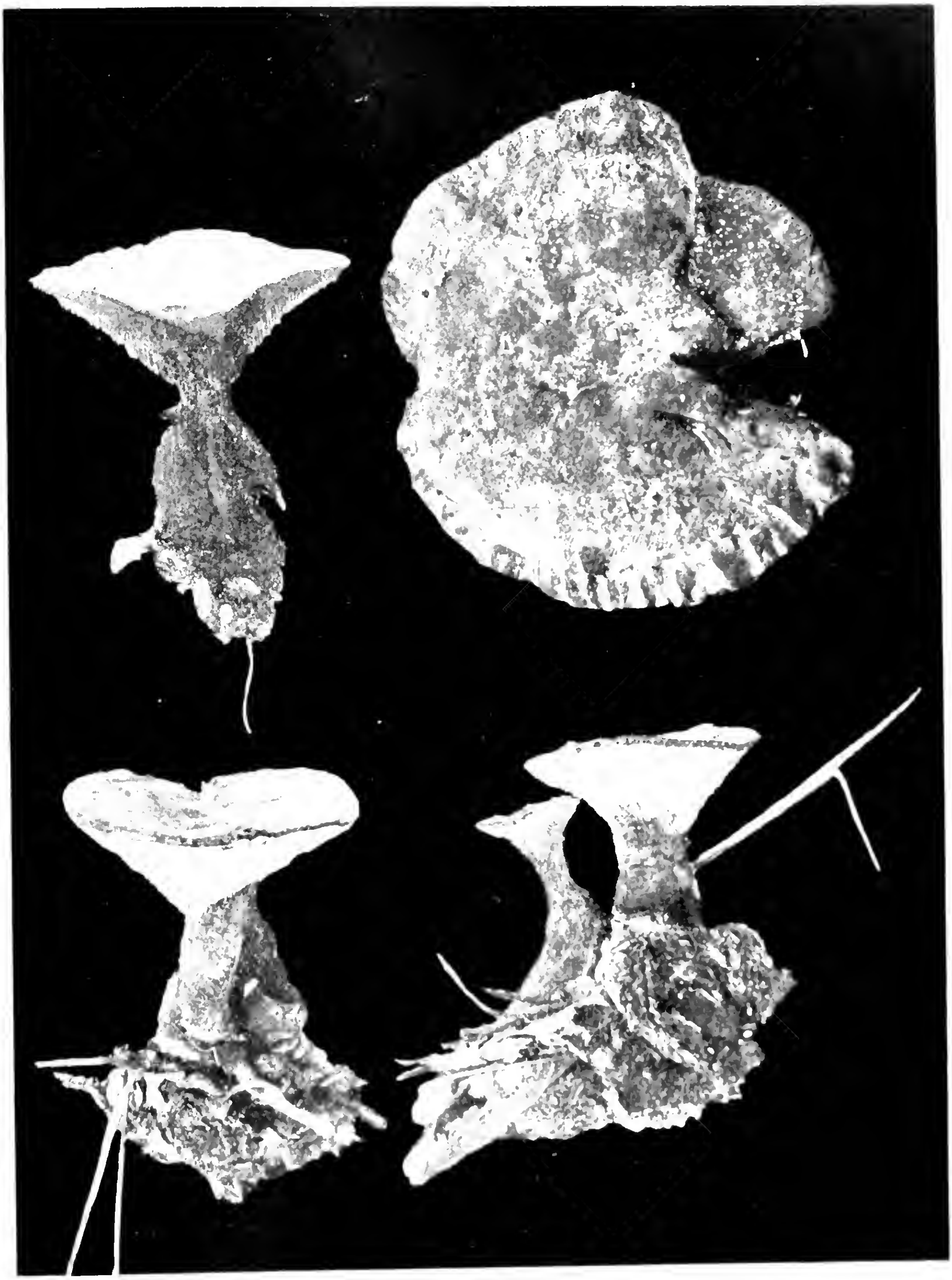
Blowing Rock. Atkinson.
Middle district, woods. Curtis.

3. **Hydnellum scrobiculatum** Fr.

PLATE 28.

Plants growing on soil in woods, gregarious and often compound by fusion, individuals about 3-8 cm. wide, compound individuals

PLATE 16



HYDNELLUM VELUTINUM

sometimes larger. Cap rather flat but irregular with pits, proliferations and asperities, at times with more or less distinct radiating ridges, the center very rough like scoria with sharp points and pits, minutely velvety, tomentose or smoothish in places, with faint structural zones; color a uniform cinnamon brown, deeper brown when bruised. Flesh usually thin, very tough and firm except for a very thin superficial felty layer, which tends to disappear in places; brittle and hard when dry; taste and odor slight; no odor of fenugreek.

Spines sharp, slender and crowded, about 3-5 mm. long, short and fading away towards the sterile margin, at first pallid and then a deep brown color; somewhat decurrent.

Stem usually slender and short, up to 3 cm., mostly about 2 cm. long; surface about color of cap, covered with a thin layer of soft spongy tissue which surrounds and binds adjoining particles; center hard and tough.

Spores roughly globose, unevenly tuberculate, about 4-4.8 x 5μ in diameter.

This species is most like *H. zonatum*, from which it is distinguished by the thicker and more rigid substance, by the nonzonate and much rougher cap, the center usually with sharp pits and proliferations like scoria. Our plants look just like Fries' figs. (Plate 5) and like several collections under this name at the New York Botanical Garden.

292. Low place in deciduous woods with scattered pines southeast of athletic field, September 25, 1908.

4. **Hydnellum zonatum** (Batsch) Karst.

PLATES 1, 17, 18, AND 28.

Plants terrestrial, thin, pliable and toughish, gregarious and often concrescent in groups, what appears to be one cap from the surface often having several stems. Cap up to 7.3 cm. wide, usually 3.5-6 cm., nearly plane, commonly somewhat depressed in center, sometimes, as in No. 1323, extremely rugged and complicated with the center filled with deep pits and pointed projections; margin a pretty,

clear flesh-pink or onion-skin pink, darkening by distinct zones through pinkish-cinnamon brown to deep Vandyke brown or pecan brown in center; radiating ridges are usually rather distinct. Flesh thin, firm, tough, homogeneous, but zoned, color of surface, about 3 mm. thick near center, very thin towards margin; taste and odor woody, or, in No. 1849, faintly like that of *Mutinus.*

Stem usually short, 0.5-2 cm. long, 4-6 mm. thick at top, much stouter below, pinkish when young and then darkening like cap. Flesh solid and same texture throughout, somewhat harder than the cap, darker than the surface when young, of the same color when old.

Spines small, rather blunt, not fimbriated. From 1-2.5 cm. long, pinkish on the very edge, but soon becoming a deep rich brown like the darkest parts of the cap.

Spores (of No. 1238) light smoky-purple, subspherical, coarsely tuberculate, one large oil drop, 3.4-5μ in diameter.

While our plants show the pink margin in most cases it is well to note that this color may not be observable when the plants are collected.

These plants would seem to be as easily referred to *H. vespertilio* as to *H. zonatum*, except for the absence of the scabrous yellow dots that Banker says are characteristic of that species (Mycologia **5**:199. 1913). Perhaps the two species are not distinct. *H. concrescens* is also very near if not the same.

297. Battle's Park, by path near Dr. Battle's house, September 21, 1908.

297*a*. On a bank near Howell's Spring, October 23, 1911. Spores 3.5-4.5 x 4-5.5μ.

827. Mixed woods, Battle's Park, September 23, 1913.

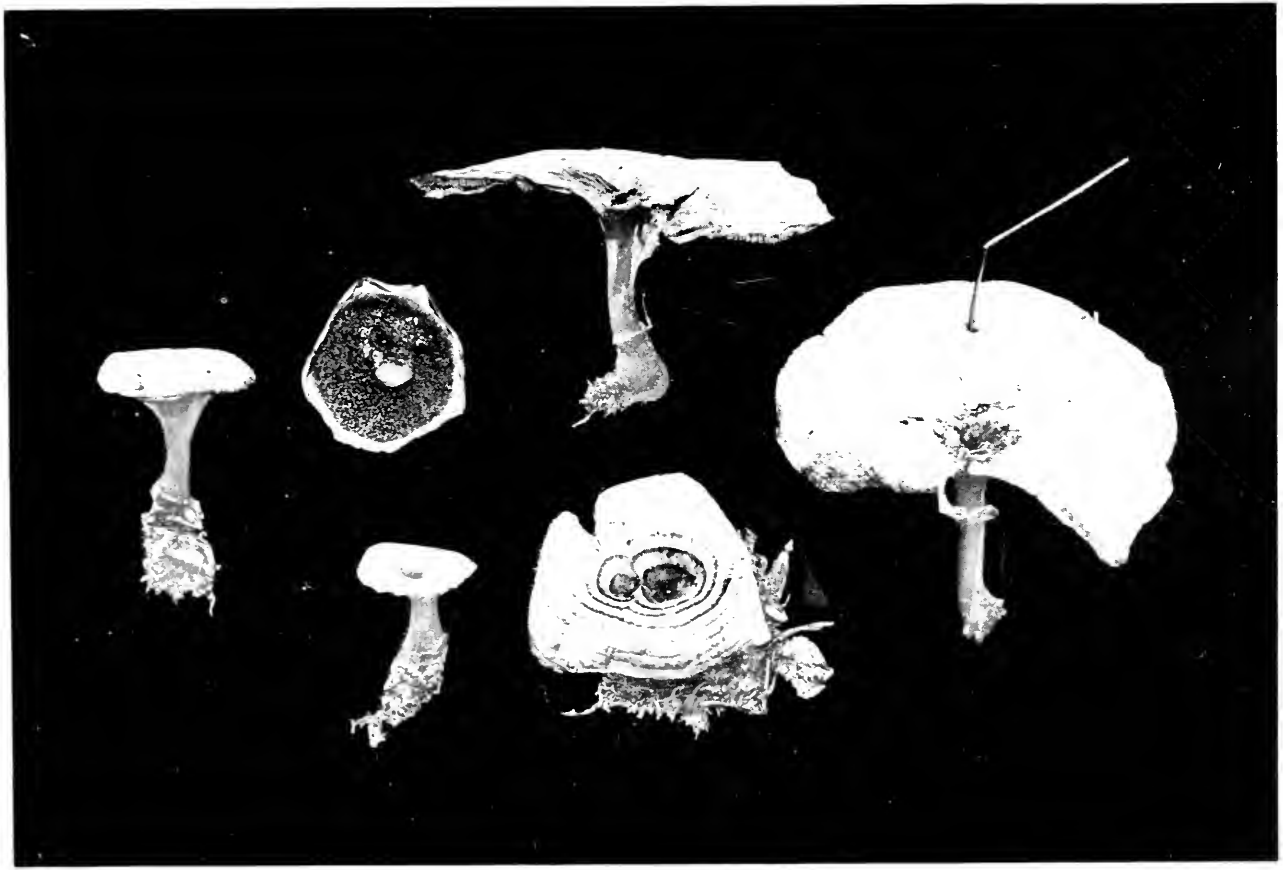
1238. Growing in rather sandy soil by branch 100 yards above the Meeting of the Waters, September 21, 1914. Photo and painting.

1323. On ground near branch due east of Dr. Battle's, deciduous woods with a few scattered cedars, October 9, 1914. Photo.

1346. Woods east of graded school, October 15, 1914. Spores a smoky-purple color, very irregular in shape with tubercles and angles, one oil drop, 4.2-5μ in diameter.

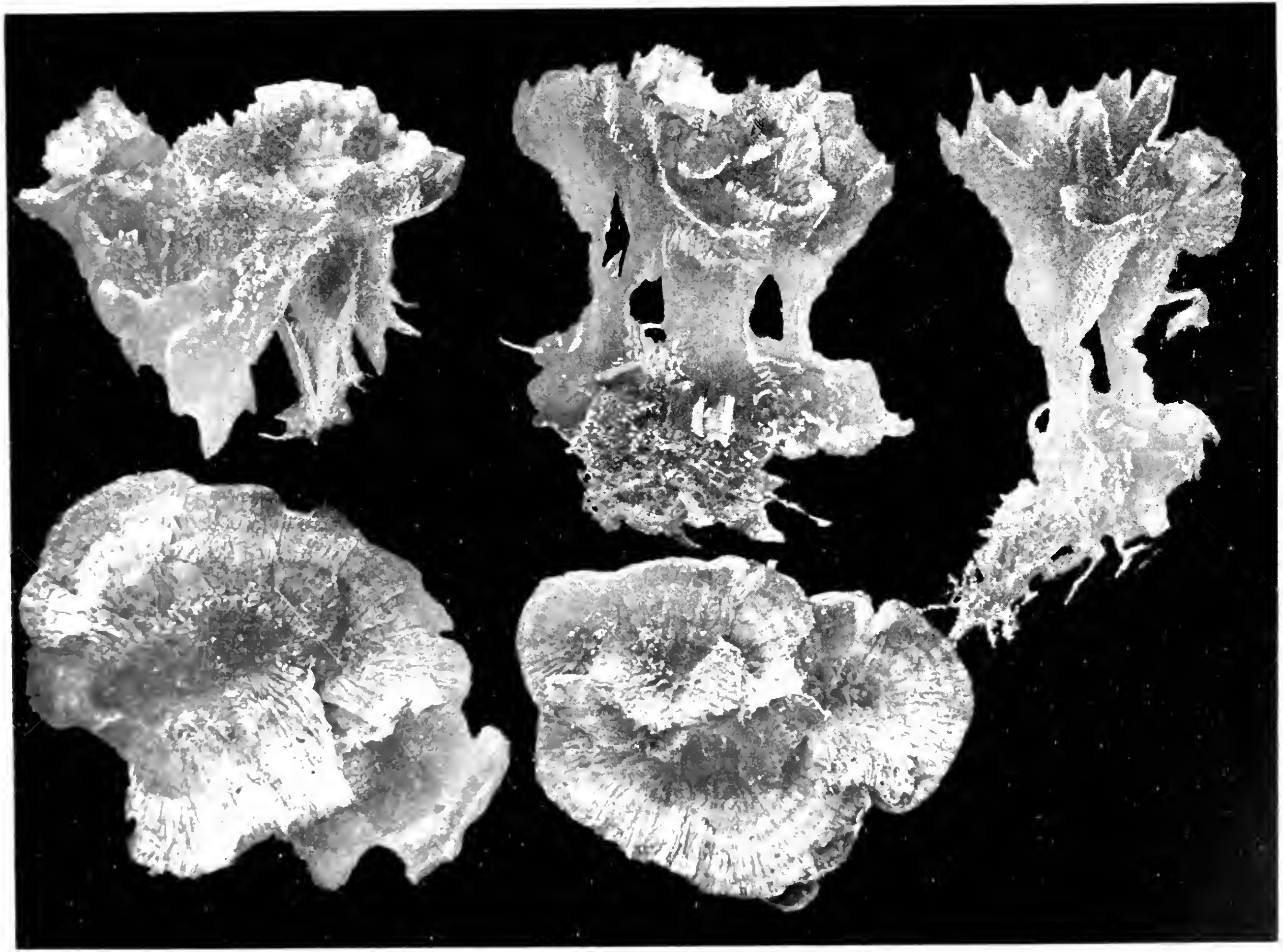
1849. By path along branch north of Meeting of Waters, September 15, 1915. Odor distinct, not of fenugreek, but faintly like that of *Mutinus* although not very disagreeable. Plants extremely thin, pliant, flesh 1 mm. thick, spines 1 mm. long.

PLATE 17



HYDNELLUM ZONATUM. No. 1849

PLATE 18



HYDNELLUM ZONATUM No. 1323

5. **Hydnellum floriforme** (Schaeff.) Banker
Hydnum aurantiacum (Batsch) A. & S.

PLATES 19, 20, AND 28.

Plants terrestrial, solid, firm and stocky, mostly very irregular, with protuberances, cavities, channels and proliferations, often confluent. Caps thick, passing gradually or rather abruptly downward into the stout stems; 3-7 cm. wide, usually about 4-5 cm.; surface finely tomentose on unweathered parts; color a rich orange salmon in younger parts, deepening towards the center to a strong, deep rust color (ferruginous and cinnamon rufus—Ridgway). As the plant ages the bright colors fade to a deep rusty brown, and then to almost black as decay sets in. In drying, the lively colors of fresh plants are well retained. Flesh of the cap duplex, the upper layer soft, corky (very friable when dry), rather thin, about 0.3-1 mm. thick, colored like the surface; on exposure to rain becoming collapsed, denser and scarcely obvious; lower layer also rather thin usually, tough, firm and elastic, a deep reddish brown with zones of yellowish brown, or the zones blackish; odor in drying faint, but distinct and fragrant. It is not at all like fenugreek, and remains undiminished after years.

Spines small and slender, only about 1.5 mm. long, greyish tan near the margin deepening to a rich reddish brown, and in age to a deep brown.

Stem thick, short, very firm, subequal, about 0.7-1.3 cm. thick, usually somewhat enlarged below; surface undergoing the same changes of color as the cap; no spongy outer layer; the firm, solid flesh distinctly zoned.

Spores (of No. 1241) purplish brown, roughly spherical and coarsely tuberculate, 3.8-4.2 x 4-5μ.

The plant is rather frequent in both pine and deciduous woods, but seems to prefer pines. According to Fries it grows in pines and has no odor. In general appearance this species is much like *H. scrobiculatum* except for the lively colors. For other figures of this species see Gillet, Champ. d. Fr., Pl. 313 (78), and Schaeffer, Fung. Bav., etc., Pl. 146., fig. 4.

1241. Among pine needles by path along Battle's Brook, September 19, 1914. Painting and photo.

1244. Among oak leaves in wooded pasture about one-half mile west of graded school, September 22, 1914.

1847. Under pines, Battle's Park, near second bridge above Indian Spring, September 20, 1915.

Middle and upper districts, hillsides. Curtis.

6. **Hydnellum ferrugipes** n. sp.

PLATES 21 AND 29.

Plant solid and heavy, of medium size, our specimens about 4.5-5.5 cm. broad, the cap rather regular and only slightly lobed or complicated, slightly to distinctly depressed in the center, the blunt margin sterile and pale below; surface finely felted tomentose or on expansion mostly smooth, even or more or less pitted, not zonate, color pale buff or dull tan or mottled with deep brown on exposure, the growing parts becoming blackish when rubbed. Flesh zonate towards the margin, duplex but not so sharply contrasted as in *H. velutinum*, *P. amicus*, etc., a rather thick, buffy upper layer of a firmly corky texture, passing more or less abruptly into a hard and darker brown layer below. Odor very faint, slightly musty, as is also the taste.

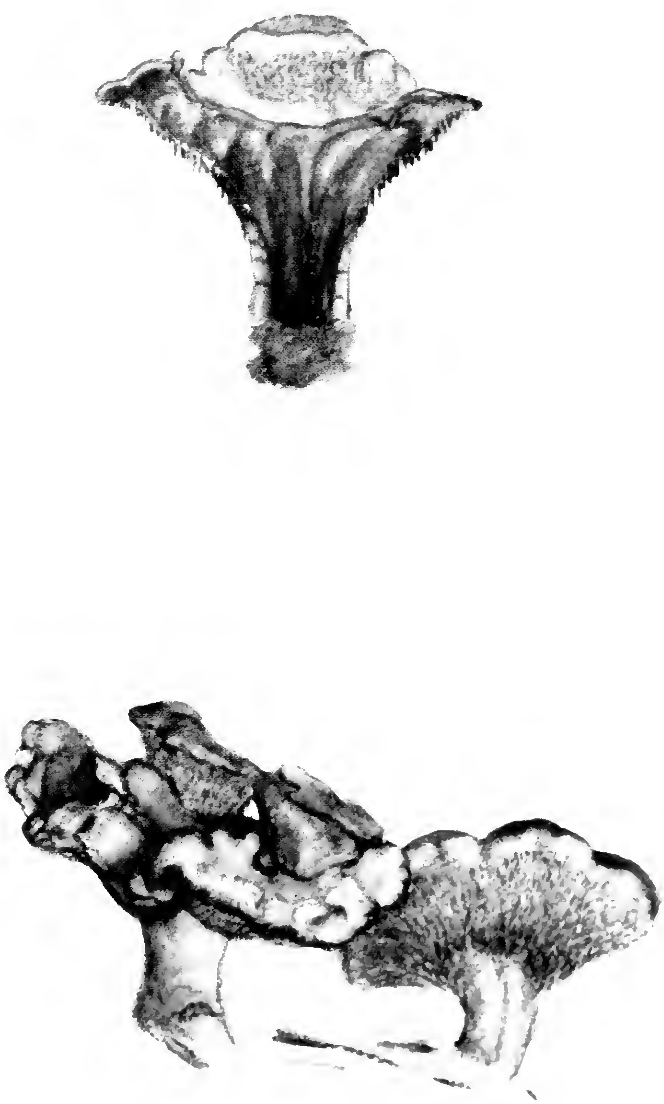
Spines up to 4 mm. long, not very slender, rather bluntly pointed when fresh, sharper when dry; pale grayish at the margin, passing through light to dark gray-brown, with a tint of salmon at times, and then to deep brown, the tips pallid until age.

Stem short, about 2-3 cm. long and 1-1.5 cm. thick, rusty red, the context consisting of a very hard and rather slender core of dark, distinctly longitudinal fibers, surrounded by a rather thick woody-corky layer of more radiating fibers of a reddish brown or rust color, only the surface of which is distinctly soft.

Spores (of No. 3201) subspherical, smoky brown, papilliate-warted, 4.6-5.6μ, some more elongated as 4.5 x 6.5μ.

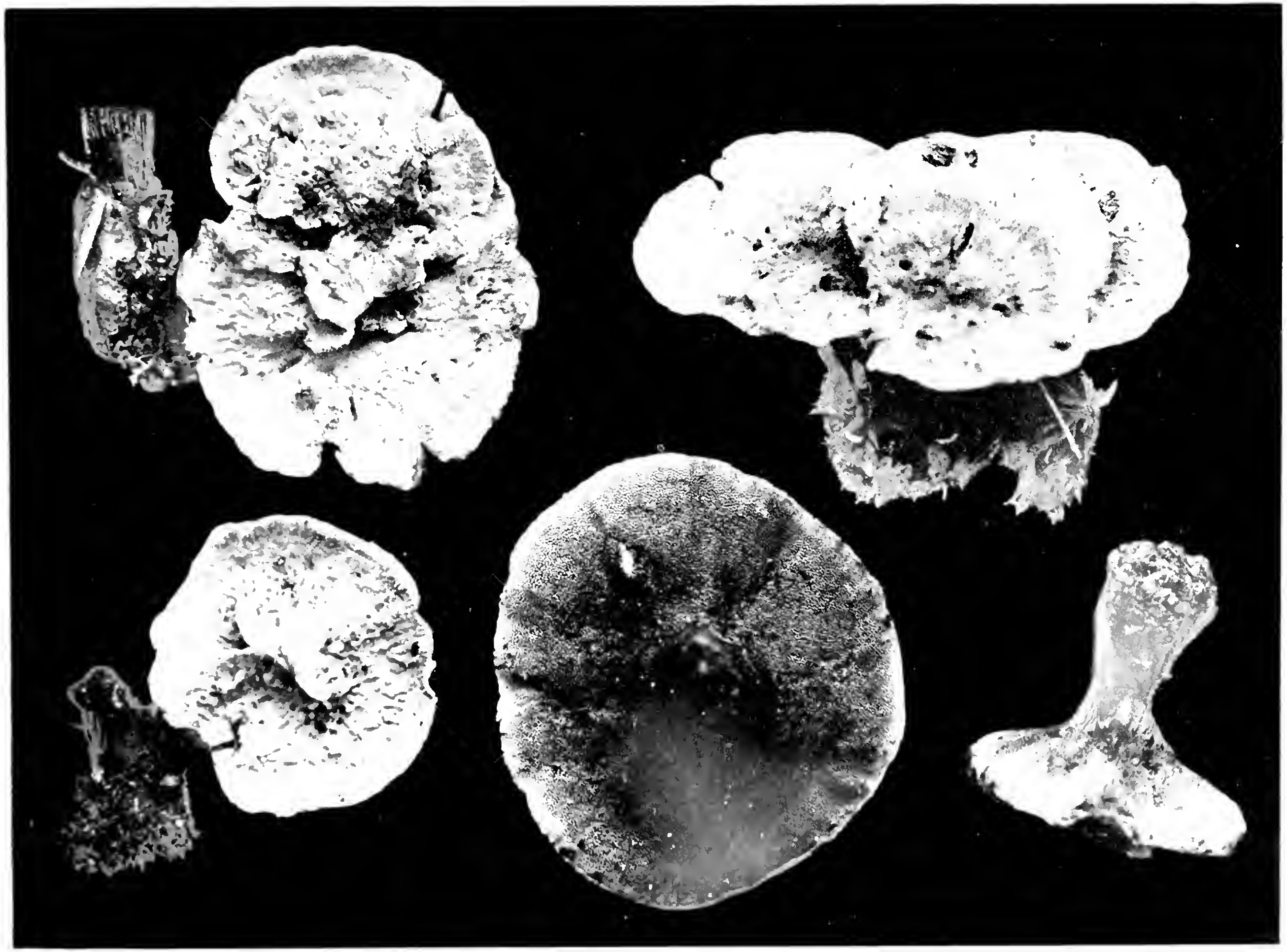
Differs from *H. floriforme* in pale color, in thicker and more compact flesh, in longer and stouter spines, in absence of a fragrance and in the distinctly larger spores. *Hydnellum complicatum* Banker differs in color and in the thinner cap and smaller spores. Shaeffer's

PLATE 19



HYDNELLUM FLORIFORME. No 1241

PLATE 20



HYDNELLUM FLORIFORME. No. 1244

PLATE 21

PHELLODON FERRUGIPES. No. 3201 (left), No. 3211 (right)

figures (Plate 146, figs. 1, 2, 3, 5, and 6) which Persoon refers to his *H. compactum* look much like our plants and I have seen no other figures that do. Fries' conception of *H. compactum* is not so different from our plant it would seem, except that in the latter there has not been noted any olivaceous tint to the cap or bluish mottling in the flesh. Banker thinks that the *H. compactum* of Persoon is probably the same as *H. floriforme* and not the plant now referred to the former species by European botanists today.

3201. In sticks and leaves of deciduous woods, low place east of athletic field, October 7, 1918. Photo. Type.

3211. Deciduous woods by Battle's Branch, October 3, 1918. Photo with No. 3201.

7. **Hydnellum carolinianum** n. sp.

PLATES 1, 22, AND 29.

Individual plants 1.5-5 cm. broad, the stems (in No. 1243) quite distinct and not confluent, but often branching at top into two or several crowded and more or less fused caps, or (in No. 1847*a*) several short-stalked caps may arise from a fused basal stratum which is deeply rooted. Surface smooth, not ridged or scrobiculate, usually convex, or the margin later becoming uplifted, closely felted-tomentose in unweathered parts, the margin undulate and lobed. Color of fresh, unweathered plants and growing margins of weathered ones a pale creamy buff (between pale yellow orange and white—Ridgway), which fades and deepens on exposure to rain to a sordid rusty brown with a tint of chocolate, and then in age to nearly black. Flesh duplex, the outer layer soft and spongy, buffy yellow and about 1-3 mm. thick; the much harder lower layer usually thinner and a lighter grayish brown color; odor almost none; no decided taste (not sour or peppery). After exposure to rain the soft flesh collapses and hardens like horn either in whole or in part, the horny, black layers being separated by lighter zones.

Spines slender, short, reaching a length of about 2 mm., when young whitish (nearly color of young cap at very margin), the main length below the tips soon turning a dark rusty brown (natal-brown—

Ridgway). The brown can be seen showing through the white surface view and gives the effect of grayish-brown to the spine surface. In age the brown encroaches still more on the white tips, but for a long time there is the effect of gray over brown. Finally the white fades entirely away and the whole becomes a deep natal-brown (almost chocolate brown).

Stem distinct, 3-4 cm. long, 0.8-2 cm. thick, irregular and dropsical in appearance; surface colored like the deeper brown shades of the old cap and spines, becoming blackish. Flesh composed of two distinct layers, a soft, spongy, water-soaked outer layer about 2-3 mm. thick which grows around and catches the trash and leaves that touch it, and a much firmer, sordid yellow-brown interior part which is zoned with darker lines.

Spores purplish-brown, subspherical, roughly and irregularly warted and angled, one large oil drop, 3.7-4.6μ in diameter.

This plant seems to be the southern representative of *H. suaveolens.* Dried plants of the two species are very similar except for the longer stems and absence of bluish or lavender zones in the flesh of our plants. However, I notice that dried plants of *H. suaveolens* often fail to show any obvious blue or violet tint to the darker zones, and I find a plant from Finland at the New York Botanical Garden (from Karsten) that has as long a stem as ours and could scarcely be distinguished from them, except for the dark purplish color of the stem surface and flesh. I have no notes on the color of the mycelium of our plants, but it could hardly be purple as that would have attracted my attention. As *H. suaveolens* is considered as distinctly a northern plant, appears to affect coniferous woods and is often quite large, it does not seem possible to refer our plant to it.

Absence of peppery taste and habitat in oak woods easily distinguish this species from *H. diabolus.* The plants are also smaller than that species and have longer stems in proportion to size. It cannot be *P. alboniger* as the black core is entirely lacking. It differs from *H. amicus* in the absence of a fetid odor and in the warty and not spinulose spores, which are also of a different color. From *H. velutinum* it differs in the lighter color, different odor, smaller spores, and in the fact that dried plants if put in a tumbler with enough water to cover

PLATE 22

HYDNELLUM CAROLINIANUM — No. 12[illegible]

will turn the water a deep brownish wine color in a short time, while plants of *H. velutinum* will turn the water only a pale cider color. The dried plants have no odor. When soaked again they have a faint rather pleasant odor, while in *H. velutinum* the odor is not restored on wetting the dried plants.

1243. Among oak leaves in open woods, one-third mile west of graded school, September 22, 1914. Photo and drawing of spores. Type.
1847*a*. In moss in mixed woods near Battle's Branch, September 20, 1915.

8. **Hydnellum humidum** Banker
Hydnum infundibulum Swartz. ?

Plates 23, 24, and 29.

A large, thin, expanded plant with a slender central or eccentric stem, often compound by fusion, growing in woods-mold near branches or springs or in depressions in deciduous woods. Cap up to 10 cm. wide, irregular, rough with radiating ridges and channels, more or less infundibuliform, especially in youth, in age usually depressed in center with the margin broadly expanded and more or less drooping; rather obscurely zonate; color light snuff-brown, near sayal-brown (Ridgway), with lighter zones towards margin, in old age turning deeper blackish-brown to black; margin repand and irregular, whitish, fertile. Flesh thin, fibrous-fleshy, firm and brittle on drying, only 1.5-2 mm. thick, except towards center; homogeneous (no spongy upper layer), no noticeable taste or odor.

Spines densely crowded, short, 1.5-2 mm. long, delicate, whitish at the tips to maturity, then becoming brown all over.

Stem 3-4 cm. long, 8-10 mm. thick above, enlarged and irregular below, color of cap.

Spores (of No. 1306) light smoky-brown, subspherical, roughly tuberculate, 3.4-5μ.

While the substance of the cap is somewhat fleshy, it is tougher and much thinner than in species of *Hydnum* or *Sarcodon*. Plants at the New York Botanical Garden of *Hydnellum humidum* from New Jersey, determined by Banker, look very like the above plants and show the same tendency to be quickly attacked by grubs and mold.

The large, thin zonate cap and very short spines are strikingly similar. The spores also are the same as in our plants, averaging about 4.5μ in diameter. Some of the New Jersey plants are strongly infundibuliform. Beardslee's plants, which he refers to *H. infundibulum*, seem the same as mine.

1306. By a spring near Meeting of the Waters Branch, about one-eighth mile above Scott's Hole, October 2, 1914. Two photos. Drawing of spores.

1856. On leaf mold on a rock by Battle's Branch (not near pines), September 22, 1915.

3220. In low place in deciduous woods east of athletic field, October, 1918. Many plants, all old and dead.

Asheville (as *H. infundibulum*). Beardslee.

GENUS PHELLODON.

This genus is like Hydnellum except that the spores are papillate or echinulate instead of warted. For all practical purposes it would be better to combine the two, and I retain Phellodon here only because Banker is describing a new species and prefers to recognize the genus.

KEY TO THE SPECIES.

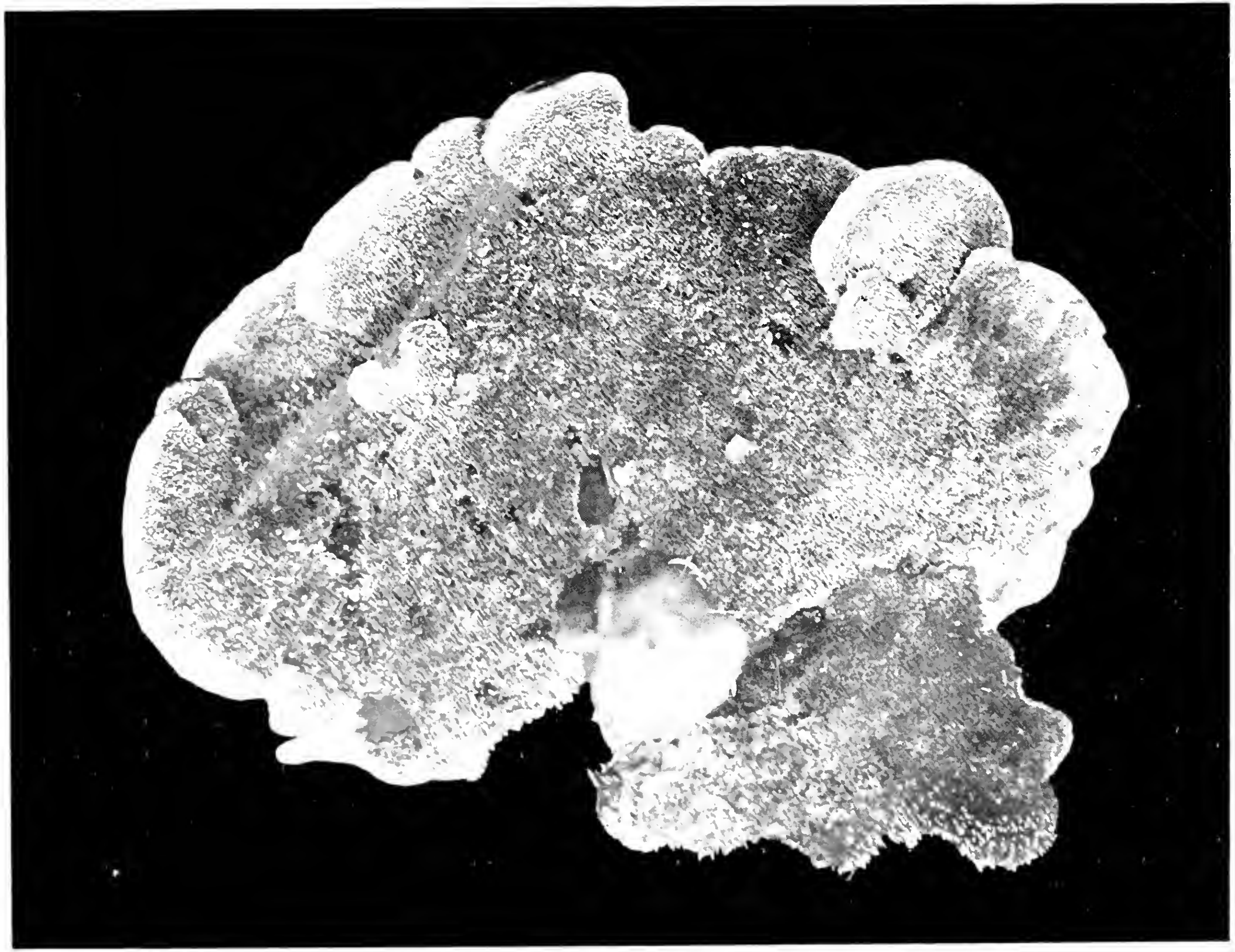
Plants very small (up to 1.5 cm. broad), mouse colored .... *P. Ellisianus* (5)
Plants averaging larger
  Flesh homogeneous
    Odor of fenugreek .... *P. Cokeri* (4)
    No odor of fenugreek .... *P. tomentosus* (3)
  Flesh spongy above, hard below, odor strong in drying
    Hard flesh black .... *P. alboniger* (2)
    Hard flesh not black .... *P. amicus* (1)

1. **Phellodon amicus** (Quel.) Banker
Hydnum putidum Atk.

PLATES 25 AND 29.

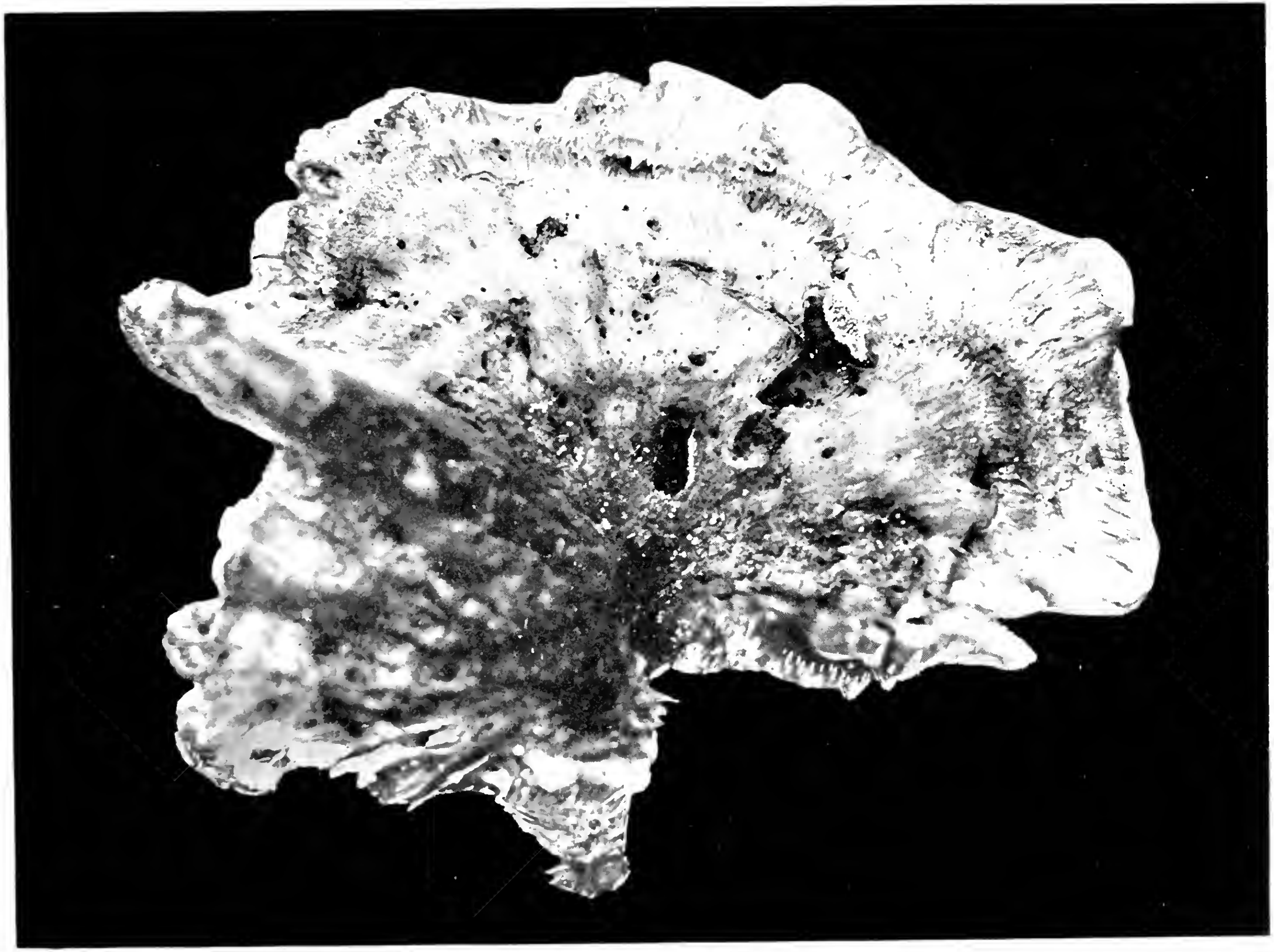
Plants reaching a size of 10 cm. broad and the same height, but usually smaller: caps and stems easily fusing into compound indi-

PLATE 23



HYDNELLUM HUMIDUM. No. 1306

PLATE 24



HYDNELLUM HUMIDUM. No. 1306

viduals. Cap very irregular, warted, pitted and channeled, usually depressed in center; surface with a fine, plush-like tomentum which is usually collapsed in the central region, in age or on exposure to rain, becoming smooth all over; color of margin whitish to light buff, changing toward the center to a deep reddish brown or gray brown, and often with a chocolate tint. The lighter color may extend far toward the center, or it may be confined to a distinct marginal zone. Flesh of two parts a very soft, spongy, superficial layer that is several mm. thick, and beneath this, next to the spines, a much firmer and deeper brown layer. The odor is penetrating and exactly like that of a pig-pen, resembling somewhat the drug fenugreek, but more disagreeable. It is faint when fresh, much stronger when dried. Taste slight, not acrid or sour.

Stem uneven, 1.5-4 cm. long, varying greatly in size, 0.5-2.3 cm. thick, usually larger and amorphous below, color of cap, the surface composed of a thick, spongy layer, the center of a hard, almost woody tissue that is deep wood brown to almost black.

Spines white their whole length when perfectly fresh, soon turning a light gray in older parts and, as drying proceeds, through a light clear salmon or directly to a light grayish salmon or grayish brown; they are crowded, very slender, and about 3-4 mm. long.

Spores (of No. 836) white, subspherical, echinulate, 3.3-4μ or a few oblong, up to 4.6μ long.

Common among leaves in deciduous woods. The species is easily distinguished from all others by the color, the strong odor and the absence of a peppery taste.

I am satisfied that our Chapel Hill plants are the same as the mountain ones named by Atkinson *H. putidum* (Mushrooms, etc., p. 199), and in this opinion Beardslee agrees. Banker, however, while thinking our plants either *H. amicus* or near, does not believe *H. putidum* to be the same. He says in a letter of January 7, 1915: "In the darker portions, combined with the tendency to become glabrate these approach *P. pullus* (Schaeff.), but in other respects they seem near *P. amicus* (Quel)." It is certain that this is the plant listed as *H. graveolens* by Curtis and it is very likely included in Fries' conception of that species.

318. Woods near Howell's Spring, September 28, 1911.
326. On ground in woods, Battle's Park, September 30, 1911.
797. Near Battle's Branch, September 16, 1913. Photo.
836. Near path in Battle's Park, directly east of Dr. Battle's house, September 25, 1913. Photo.
1276. On hillside near the branch just below Judge's spring, September 28, 1914. Two photos. Spores white, spherical, echinulate, 3.4-4.2μ.
1347. Battle's Park, north of cemetery, October 13, 1914.
1348. Woods east of Graded School, October 15, 1914.
1368. By path to Meeting of the Waters east from cemetery, October 14, 1914.
2378. Mixed pine and oak woods near Piney Prospect, July 8, 1916.
2405. Mixed woods near Meeting of the Waters, July 20, 1916. Photo.
3203. Among oak and other deciduous leaves. Hillside near Judge's Spring, October 10, 1918.

Asheville. Beardslee.
Common, base of stumps (as *H. graveolens*). Curtis.

2. **Phellodon alboniger** (Pk.) Banker

PLATE 26.

We have not found this in Chapel Hill and take the following from Beardslee's notes:

"Cap 2.5-7 cm. broad, nearly plane or slightly depressed at the center, pale, almost white, with a tomentum which covers the entire upper surface, in section showing two distinct layers, the outer pale, soft and usually water-soaked, the inner blue-black and hard.

"Teeth slender, white or gray, crowded, decurrent.

"Stem short, hard and black within, covered on the outside with a soft, spongy paler layer.

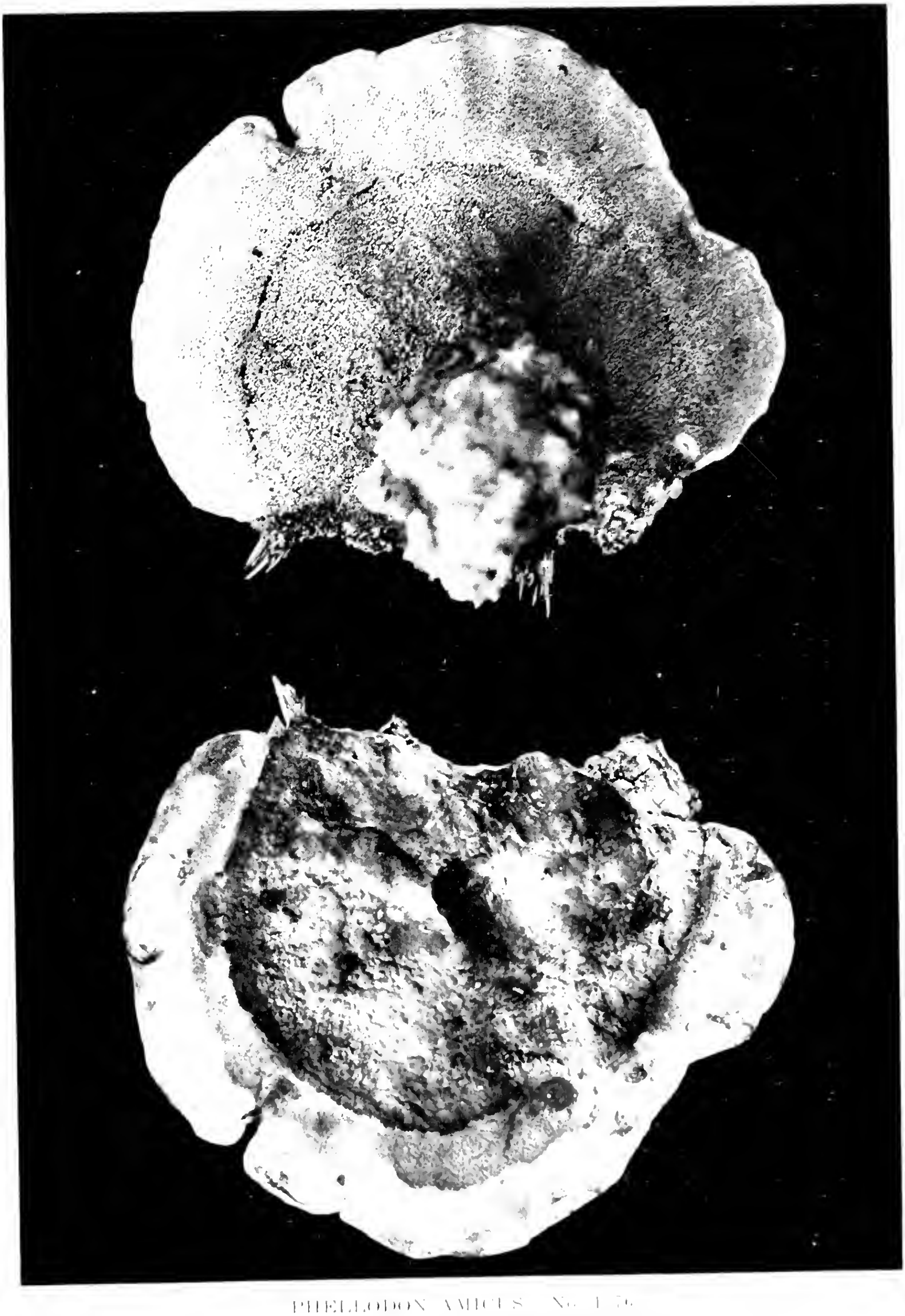
"This is not like any of our other species. The hard, black core and paler, spongy exterior are quite marked. I find it in oak woods."

Asheville. Beardslee.

3. **Phellodon tomentosus** (L.) Banker

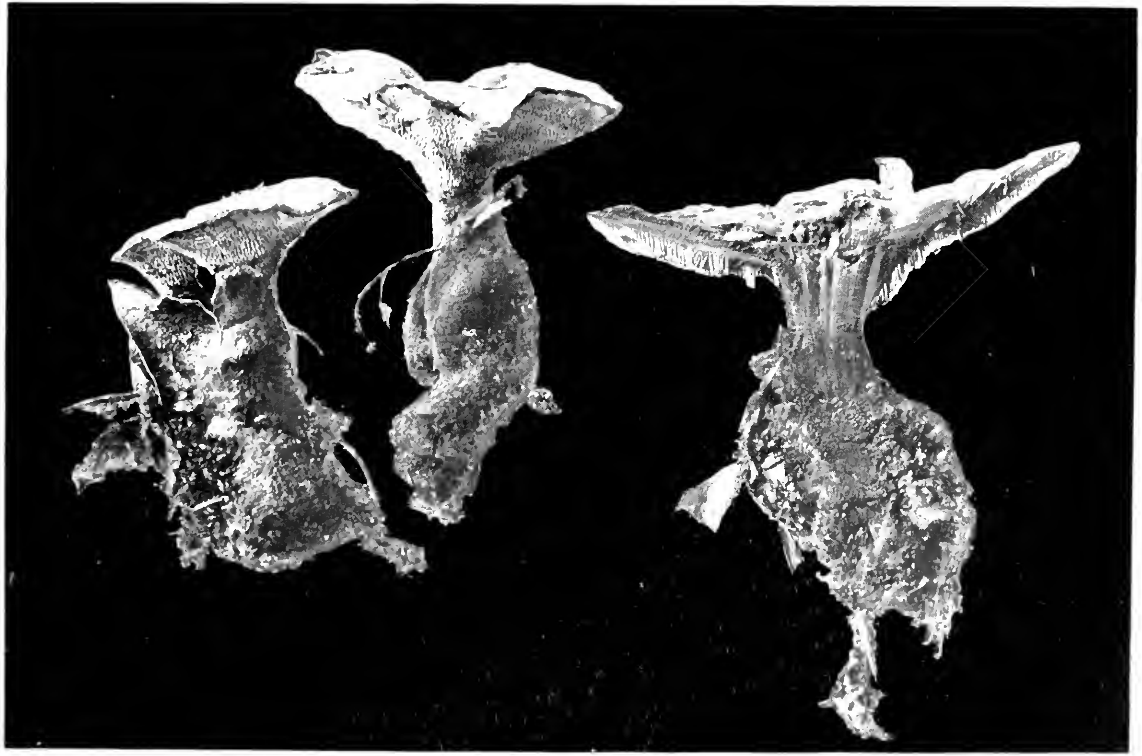
This is reported by Schweinitz, but we have not found it, and its occurrence in this state must be considered doubtful. It is mostly northern in its distribution and except for the record by Schweinitz

PLATE 25



PHELLODON AMICUS No. 176

PLATE 26



PHELLODON ALBONIGER

Photo. by Beardslee

has not been found south of New Jersey. It should be looked for in our mountains. The following is from Banker (Memoirs Torr. B. C. 12, No. 2:171. 1906):

"Plant terrestrial, mesopodous, gregarious, confluent, small, zonate; pileus plane to depressed, occasionally subinfundibuliform, nearly round, 1-2 cm. wide, often confluent into crust-like layers, sometimes several decimeters wide; surface radiately fibrous-striate, floccose-tomentose or subscrobiculate at the center of the disk, subsulcate-zonate, castaneous or darker near center to light cream-color or whitish at margin; margin thin, substerile; substance fibrous tough, thin; stem slender, terete, attenuate downward to a common floccose-tomentose base imbedded in the substratum, subpubescent, cream-colored above to glabrous dark reddish brown below, 1-1.5 cm. long, 2-7 mm. wide; teeth slender terete, acute, scarcely decurrent, whitish to cream-colored, 2 mm. long and less; spores subglobose, echinulate, white or hyaline, 3.5-4μ wide. Hab.: On ground among moss. August-November."

Middle district (Schw.) woods. Curtis.

4. **Phellodon Cokeri** Banker, n. sp.

PLATE 29.

The following description of this new species is by Dr. Howard J. Banker:

"Hymenophore terrestrial, mesopodous, gregarious, somewhat confluent, irregular and often deformed, light cinnamon brown to tawny, medium size to small; pileus obconic, depressed to subinfundibuliform, irregular, 1-6 cm. wide, 1-3 mm. thick; surface uneven, more or less scrobiculate, spongy to subpubescent, light cinnamon brown or sordid tawny, irregularly maculate, azonate; margin thin, acute, sterile; substance somewhat spongy above, harder and more compact within, very brittle when dry, concolorous with surface becoming darker toward center, azonate; stem central to eccentric, attenuate downward to an enlarged spongy base, more or less deformed, surface uneven, spongy to subpubescent, concolorous with cap, 1-3 cm. long, 3-10 mm. wide; teeth slender, terete, tapering, acute, subfleshy, ap-

pearing waxy when dried; but slightly decurrent, 'whitish when young becoming salmon' to reddish brown when dried, 3 mm. or less long becoming shorter toward margin and stem, 0.15-0.35 mm. wide, 10-12 to a sq. mm.; spores ovoid, hyaline, echinulate, 4-5 x 4.5-5.5μ wide; hyphae of trama colored yellowish brown, smooth, thin-walled, collapsing when dried, not recovering in KOH, scarcely separable in KOH, closely interwoven, branching, variable in width, 3.5-9μ wide, septate, segments very irregular, no clamp connections detected; odor strong of fenugreek.

"Type collected at Chapel Hill, N. C., on ground in woods, Battle's Park, September 19, 1908. W. C. Coker" (U. N. C. Herb. No. 47*a*).

5. **Phellodon Ellisianus** Banker

PLATE 29.

Plants small, gregarious, sometimes connate, in rather dry sandy soil in woods. Cap up to 1.5 cm. in diameter, usually 1-1.3 cm., depressed in center, the margin plane or curved; surface smooth except for the faint inherent radiations and a central area of spumy tissue which is lighter, faintly zonate, grayish-brown, about a blackish chestnut brown, and while wet irridescent with fine deep purple and green tints. Flesh tough and leathery, less than 0.5 mm. thick, with a distinct odor of fenugreek, much like that of *Phellodon amicus* but more agreeable.

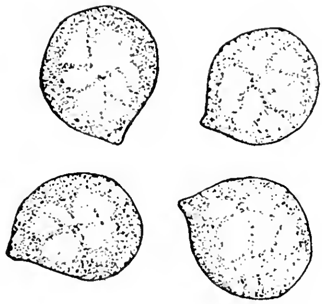
Spines very short and distant, slender, pointed, elongating from nothing near the sterile margin to about 0.6 mm. near the stem, slightly decurrent, covered all over with a fine, frosty puberulence which also covers the cap surface between them; a grayish salmon-brown color and lightest at the margin.

Stem central, tough, smooth, solid, about color of cap, turning almost black when wet after drying, about 5-6 mm. long and 1.5 mm. thick, slightly enlarged at the ground.

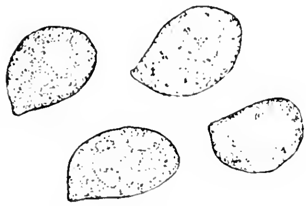
Spores hyaline, subspherical, minutely echinulate, 3.5μ in diameter.

This is a very distinct little species which was described by Banker from plants collected by Ellis in New Jersey. Our plants are the only

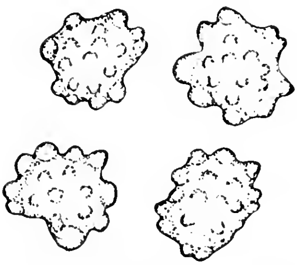
PLATE 27



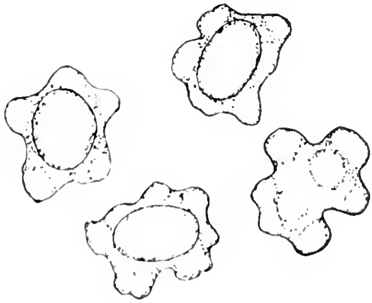
Hydnum repandum. No. 603



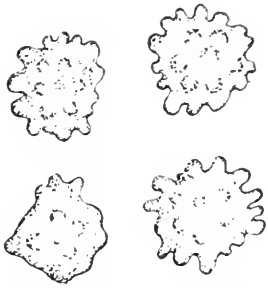
Hydnum albo-magnum. No. 1991



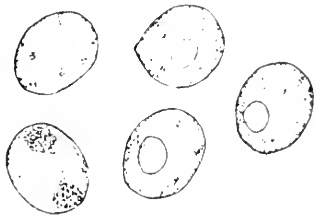
Hydnum imbricatum. No. 841



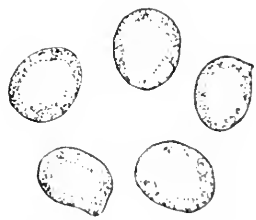
Hydnum scabripes. No. 1836



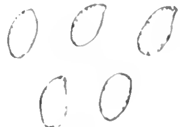
Hydnum Underwoodii. No. 1837



Manina cordiformis. No. 1277



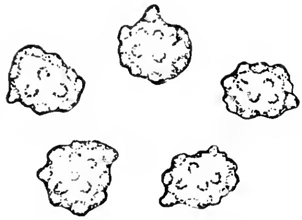
Manina flagellum. No. 1447



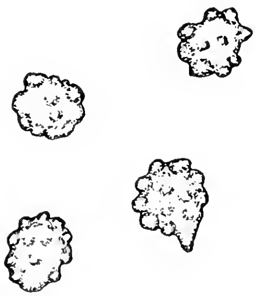
Steccherinum Rhois. No. 1511

PLATE 28

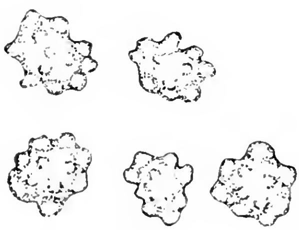
Steccherinum adustum. No. 1607



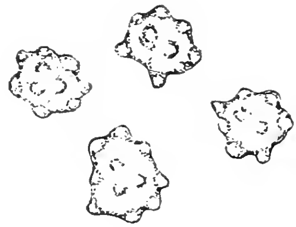
Hydnellum diabolus. No. 1341



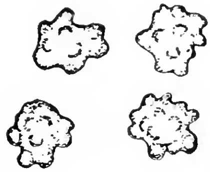
Hydnellum scrobiculatum. No. 292



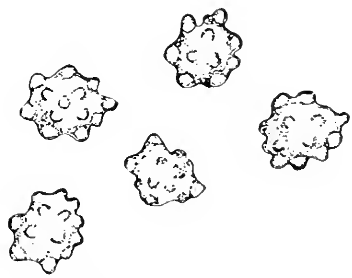
Hydnellum velutinum. No. 2412



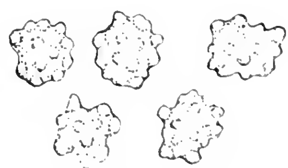
Hydnellum velutinum. Europe



Hydnellum zonatum. No. 297*a*

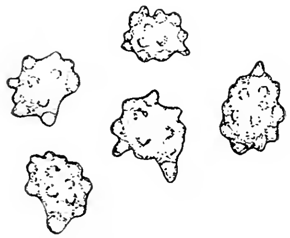


Hydnellum zonatum. Italy

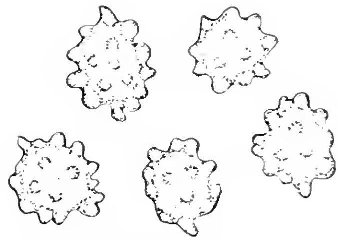


Hydnellum floriforme. No. 1241

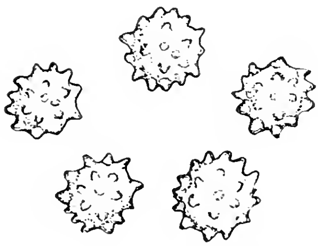
PLATE 29



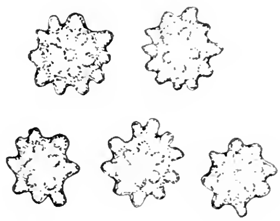
Hydnellum carolinianum. No. 1243



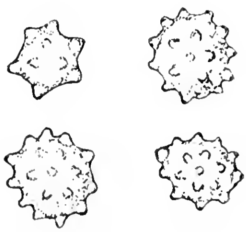
Hydnellum ferrugipes. No. 3201



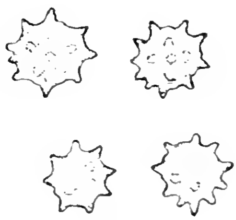
Phellodon amicus. No. 836



Hydnellum humidum. No. 1306



Phellodon Cokeri. No. 47*a*



Phellodon Ellisianus. No 1325

ones that have been found since. They are like the type plants in the New York Botanical Garden except that the spines in the latter are closer and better developed than in ours.

1325. On rather dry sandy soil in woods southwest of cemetery, October 6, 1914. Drawing of spores.

GENUS HYDNOCHAETE.

Resupinate, very thin, fibrous, the teeth simple or branched, usually flattened towards the ends; growing on wood. This seems to be a connecting link between the *Hydnaceae* and the *Polyporaceae*, and Murrill places the genus in the latter family as *Hydnoporia*. As our plants show no signs of tubes even in the youngest stages, I think it less confusing to retain it in the Hydnaceae. We have but one species.

Hydnochaete olivaceum (Schw.) Banker

Irpex cinnamomeus Fr.

Hydnoporia fuscescens (in N. Am. Flora **9**:3. 1907).

This is a peculiar plant, forming pendant, hydnoid teeth from an extensive, resupinate layer or from separate patches. The teeth are usually about 1 mm. long and branched once or twice, often flattened and appearing like the horns of a caribou; in extreme forms, as our No. 1973, the teeth may be much longer and more complexly branched, reaching 4 mm. in length. Resupinate portion and basal part of teeth tomentose. Entire plant a rusty cinnamon color. Texture tough and pliable when fresh, brittle when dry.

Setae (of No. 961) long, pointed, thick-walled, deep reddish brown, 8-12.5 x 50μ. Spores not found.

90. On dead beech limb in Battle's Park, October 18, 1911.
961. On dead beech limb by Durham road near bridge, October 29, 1913.
1973. On a fallen oak limb, Battle's Park, November 10, 1915.
3218. On a dead limb of tulip tree near Judge's Spring, October 9, 1918.

Asheville. Beardslee.
Common, trunks and limbs. Curtis.

A NEW SPECIES OF AMANITA.

BY H. C. BEARDSLEE.

Amanita mutabilis n. sp.

PLATES 30 AND 31.

Cap 5-9 cm. broad, white or very pale cream color, not viscid, appearing smooth, but with flat closely appressed fragments of the volva which are slightly darker than the cap; slightly striate on the margin.

Stem 4-8 cm. long, 1-1.5 cm. thick, white, *solid*, fibrillose below the veil, abruptly enlarged below into a bulb 2-3 cm. thick, sheathed by the volva, which separates in a circumscissile manner with a distinct free margin.

Gills rather broad, white, mealy on the margin.

Veil thin, smooth, often breaking and forming fragments which remain attached to the margin of the cap.

Spores oblong ellipsoid, 6.5-7.5 x 11-14μ.

Odor not at all of chlorine, but rather pleasant and oily. Flesh of the stem changing to carmine (about Eugenia red of Ridgway) in three minutes.

Growing in white sand on Davis Island, N. C.

The characters of this species suggest a relationship to *A. pantherina* and *A. cothurnata*. It has the same curious sheathed bulb at the base of the stipe. In every specimen examined the volva had separated at the margin of the bulb in a definite line, and the margin had rolled back slightly, exactly as in *A. pantherina*. The cap if not carefully examined would be described as smooth. The remains of the volva are, however, left on the surface of the cap, and can be distinguished as slightly darker spots, and can be rolled up in rolls if the cap is gently rubbed. The quick change of color when the stem is wounded is different from anything I have observed in Amanita. The change

PLATE 30

AMANITA MUTABILIS

Photo. by Beardslee

PLATE 31

AMANITA MUTABILIS

Photo. by Mrs. Ravenel

is much quicker and much more distinct than in *A. rubescens*. Three minutes seemed to be the usual period for developing a deep carmine. It seems amply distinct from the other sheathed Amanitas in character and its spores.*

ASHEVILLE, N. C.

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*NOTE BY THE EDITOR.—Soon after Mr. Beardslee found the Davis Island plants a photograph was sent me by Mrs. I. M. Jervey of Charleston, and later a collection of dried plants of this species. The quick change to bright red was noted by Mrs. Jervey for her plants also, and I find the spores nearly the same (7.4-8 x 11-13 μ). I publish herewith the photo by Mrs. Jervey, which shows a good veil.—W. C. C.

JOURNAL

OF THE

Elisha Mitchell Scientific Society

VOLUME XXXV
1919-1920

ISSUED QUARTERLY

Published for the Society
by the
University of North Carolina

CONTENTS

DOUBLE NUMBER

VOL. XXXV OCTOBER, 1919 Nos. 1 & 2

JOURNAL

OF THE

Elisha Mitchell Scientific Society

CONTENTS

ISSUED QUARTERLY

CHAPEL HILL, N. C., U. S. A.

ENTERED AT THE POST OFFICE AS SECOND-CLASS MATTER

The Elisha Mitchell Scientific Society

Journal of the Elisha Mitchell Scientific Society—Quarterly. Price $2.00 per year; single numbers, 50 cents. Most numbers of former volumes can be supplied. Direct all correspondence to the Permanent Secretary, at University of North Carolina, Chapel Hill, N. C.

PLATE 1

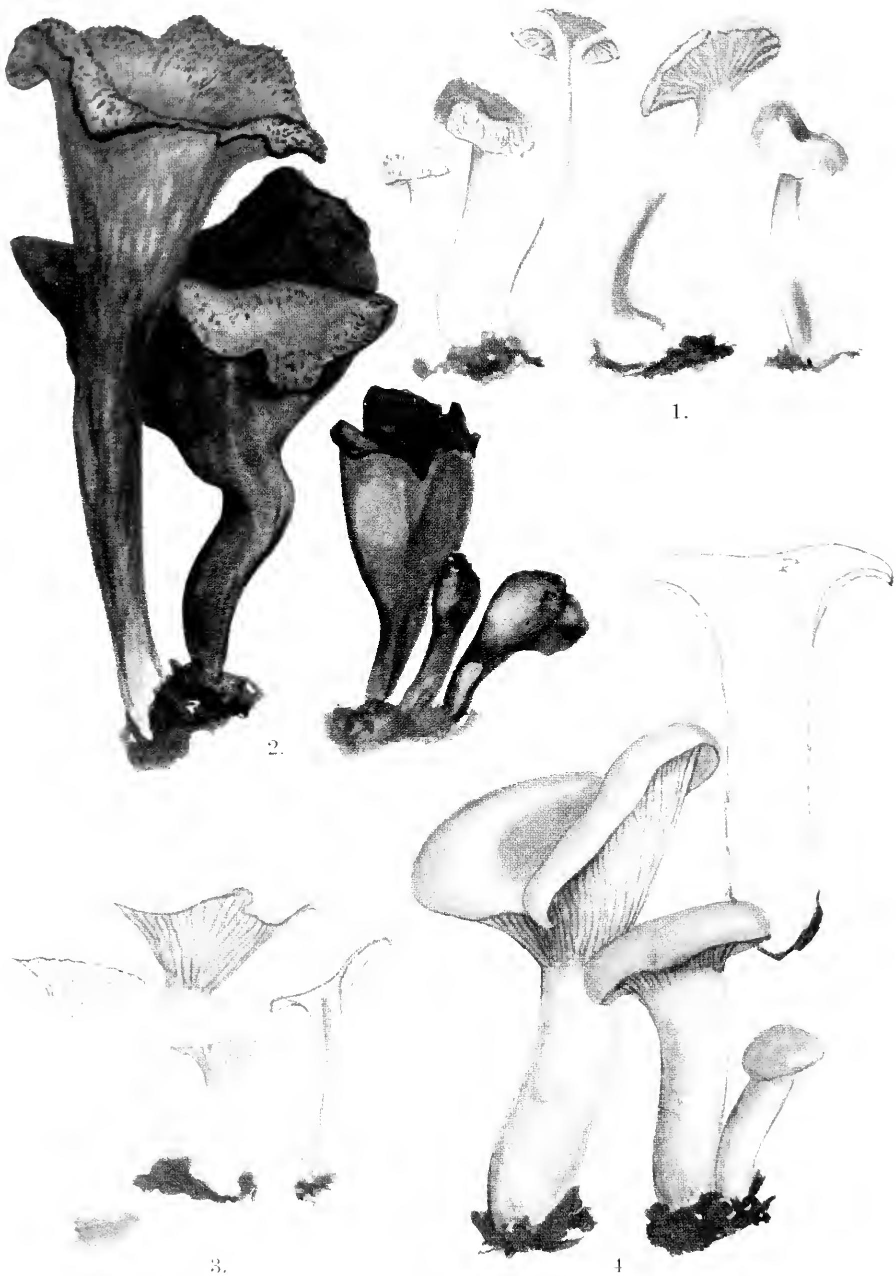


FIG. 1. CANTHARELLUS INFUNDIBULIFORMIS. No. 3263. FIG. 2. CRATERELLUS CORNUCOPOIDES. No. 3261. FIG. 3. CANTHARELLUS CINNABARINUS No. 3265, and ORANGE FORM No. 3360. FIG. 4. CANTHARELLUS CIBARIUS. No. 3293

Painted by Dorothy Coker.

JOURNAL

OF THE

Elisha Mitchell Scientific Society

Volume XXXV OCTOBER, 1919 Nos. 1 and 2

PROCEEDINGS OF THE EIGHTEENTH MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT TRINITY COLLEGE, DURHAM, N. C., MAY 2 AND 3, 1919.

The executive committee met at 12:00 M. on Friday with the following members present: President E. W. Gudger, Secretary Bert Cunningham, and Dr. J. J. Wolfe. Prof. Z. P. Metcalf was made a member *pro tem.* The Secretary made a report on the finances which appears at its proper place in the records. The report on membership showed that at present there are 91 members, 8 of whom are in the army. Four members have resigned. Fourteen new members were elected, and these are included in the above total. New members elected are as follows:

Andrews, W. H., Assistant in Geology, University of North Carolina.

Binford, Raymond, President of Guilford College.

Bynum, J. C., Instructor in Geology, University of North Carolina.

Davis, H. T., Assistant in Geology, University of North Carolina.

Edgerton, F. N., Jr., Assistant Professor of Engineering, Trinity College.

Hatley, C. C., Instructor in Physics, Trinity College.

Krausz, H. B., Farm Forestry Specialist, Raleigh, N. C.

Markham, Blackwell, Medical Student, University of North Carolina.

PETTY, MISS MARY, Professor of Chemistry, State College for Women.

RHODES, L. B., Chemist, Raleigh.

SAVILLE, THORNDIKE, Associate Professor of Sanitary Engineering, University of North Carolina.

SHAFFER, MISS BLANCHE E., Department Home Economics, State College for Women.

SHERRILL, MISS MARY L., Associate in Chemistry, State College for Women.

VANN, MISS FANNIE E., Instructor Mathematics, Durham City High School.

An invitation was extended and accepted to hold the next meeting of the Academy at Wake Forest.

The executive committee then adjourned.

At 2:30 p. m. President Gudger called the Academy to order and appointed the following committees: Auditing, Z. P. Metcalf, J. M. Bell, R. N. Wilson; Resolutions, Collier Cobb, Miss Mary Sherrill, R. W. Leiby; Nominating, H. V. Wilson, W. H. Pegram, C. S. Brimley.

The reading of papers was then begun and carried on until 5:30 p. m. The Academy reconvened at 8:00 p. m. and were welcomed to the college by President Few. This welcome was responded to by President Gudger on behalf of the Academy. The Presidential address was then given (see abstract below). At 9:30 p. m. the Academy adjourned to the Faculty Club Room and became the guests of the Faculty of Trinity College at a "get acquainted gathering" called a Reception.

The Academy was called to order by the President at 9:00 a. m. Saturday for the business session. The minutes of the last meeting were read and approved. The Treasurer made his report which is appended hereto. This had been audited and ordered printed.

The nominating committee reported and the following officers were elected for the ensuing year:

President—A. H. Patterson, Professor of Physics, University of North Carolina.

Vice-President—R. N. Wilson, Professor of Chemistry, Trinity College.

Secretary-Treasurer—R. W. Leiby, Entomologist, Raleigh.

Executive Committee (additional members)—Z. P. Metcalf, H. B. Arbuckle, Miss Mary Sherrill.

The Resolutions Committee reported, as follows:

Resolved, That we, the members of the North Carolina Academy of Science, express to the President and Faculty of Trinity College our hearty appreciation of their hospitality, extended to us on the occasion of the eighteenth annual meeting of the Academy. Nothing could have been more delightful than their arrangement for our social intercourse which has been stressed here even more than at former meetings.

The Committee on High School Science reported that no meeting had been held. This committee was reconstituted, by action of the Academy, with Dr. E. W. Gudger as chairman, the other members being the same, and continued. There was considerable discussion over the question.

It was moved and carried that all members in the army should be continued without the payment of dues for this year.

At 10:30 the joint meeting of the Chemists and Academy was held.

At 11:30 the Chemists withdrew for their special meeting, and the Academy proceeded with the papers. Adjournment for dinner was had at 1:00 p. m. and the Academy reconvened at 2:00 and proceeded with papers until 4:30. After this Mr. G. A. Rhea demonstrated a motion picture machine, using a nitrogen lamp and a noncombustible film. The Academy then adjourned *sine die*.

REPORT OF BERT CUNNINGHAM, TREASURER, 1918–1919

RECEIPTS

Dr. E. W. Gudger, Treas....	$ 138.97
Dues......................	68.00
Savings acct. interest......	1.30
Total receipts	$ 208.27
Less expenditures	13.10
Balance	$ 195.17

RESOURCES

Saving acct.	$ 131.30
Checking acct.	63.22
Cash on hand.............	.65
	$ 195.17

OTHER RESOURCES ESTIMATED

Due from chemists........	$ 2.50
Stamps on hand (about)...	.50
Dues unpaid (about).......	28.00
Estimated resources....	$ 226.17
Less outstanding bills..	82.00
Estimated balance	$ 144.17

EXPENDITURES

Stamps	$ 5.00
Notices	2.00
Stationery	4.75
Clerical services	1.00
Express	.35
	$ 13.10

DEBTS OUTSTANDING

Journal	$ 75.00
Programs	6.00
Secretary's fee	1.00
	$ 82.00

Following is the present membership. Those present at the meeting are starred, those in the army are marked (*a*):

Arbuckle, H. B.....................................Davidson
*Andrews, W. H.................................Chapel Hill
Bahnson, F. F...............................Winston-Salem
Beardslee, H. C..................................Asheville
*Bell, J. M...Chapel Hill
Binford, Raymond.........................Guilford College
*Bivins, Mrs. F. C.................................Durham
Bonney, Miss E. C..........................Hartsville, S. C.
Bottum, Miss F. R.................................Raleigh
*Brimley, C. S......................................Raleigh
*Brimley, H. H......................................Raleigh
Bruner, S. C.....................Santiago de las Vegas, Cuba
*Bynum, J. C.....................................Chapel Hill
Cain, Wm. ....Chapel Hill
Clapp, S. C......................................Swannanoa

*Cobb, Collier....................................Chapel Hill
Cobb, Wm. B..............Bureau of Soils, Washington, D. C.
*Coker, W. C....................................Chapel Hill
Collett, R. W..Raleigh
*Cunningham, Bert............Care Dept. Zool, Madison, Wis.
*Davis, H. T....................................Chapel Hill
Detjen, L. R..................................West Raleigh
Downing, J. S.............................Elsmere, Delaware
*a*Dixon, L. F....................................——————
*a*Dobbins, C. N..................................——————
*Edwards, C. W.......................................Durham
*Egerton, F. N., Jr..................................Durham
Farmer, C. M..............................Lynchburg, Va.
*a*Field, R. H....................................——————
*Gudger, E. W...................................Greensboro
*Hatley, C. C..Durham
Hewlett, C. W...................................Greensboro
Hickerson, T. F.................................Chapel Hill
*a*Hoffman, S. W..................................——————
*Holmes, J. S...................................Chapel Hill
*a*Johnson, E. D..................................——————
Kilgore, B. W.......................................Raleigh
Kraüsz, H. B..Raleigh
Lake, J. L.....................................Wake Forest
Lanneau, J. F..................................Wake Forest
*Leiby, R. W..Raleigh
Lewis, R. H...Raleigh
Marion, S. J..Raleigh
*Markham, Blackwell ....Chapel Hill
Mendenhall, Miss Gertrude W.....................Greensboro
*Metcalf, Z. P.................................West Raleigh
Nowell, J. W...................................Wake Forest
Patterson, A. H.................................Chapel Hill
*Pegram, W. H..Durham
*Petty, Miss Mary...............................Greensboro
Poteat, W. L...................................Wake Forest
*a*Pratt, J. H....................................Chapel Hill
Rankin, W. S..Raleigh
*Rhodes, L. B.......................................Raleigh
Riddick, W. C..................................West Raleigh
Robinson, Miss Mary.............................Greensboro
*Saville, Thorndyke ....Chapel Hill
Sherman, Franklin, Jr...............................Raleigh
Seymore, Miss Mary F................................Raleigh
*Shaffer, Miss Blanche E........................Greensboro
Shore, C. H...Raleigh

*Sherrill, Miss Mary L. .... Greensboro
Strong, Miss Cora .... Greensboro
*a*Stiles, C. W. .... ———
Smith, J. E. .... Ames, Iowa
*a*Totten, H. R. .... Chapel Hill
*Vann, Miss Fannie E. .... Durham
*Venable, F. P. .... Chapel Hill
*Wheeler, A. S. .... Chapel Hill
*Wilson, H. V. .... Chapel Hill
Williams, L. F. .... Raleigh
*Wilson, R. N. .... Durham
Withers, W. A. .... West Raleigh
Wolf, F. A. .... West Raleigh
*Wolfe, J. J. .... Durham

The following papers were then presented:

On the Use of the Sucking-Fish, Echeneis or Remora, For Catching Fish and Turtles. (Presidential Address) E. W. GUDGER.

This paper gave a careful review of all the published accounts of this use of this interesting fish. The first European who ever beheld this curious method of fishing was Christopher Columbus on his second voyage, May 19, 1494, on the south side of Cuba. The first printed account came from the press of Albertino Vercelles da Lisona at Venice on April 10, 1505, and this account is repeated with variations by all the Spanish chroniclers of the early explorations in the West Indies.

It has long been so used in the Mozambique country and in Madagascar. The literature contains at least five references. The earliest printed one dates back to Dampier in 1729, but there is a native Malagassy manuscript, which gives an account probably long antedating the printed accounts.

It is known to be practiced at the present time by the Chinese fishermen of Singapore, but the greatest wealth of references is to the use of this fish for taking turtles by the aborigines of Torres Straits, between Australia and New Guinea. To its use here no fewer than ten separate writers testify, some of these eye-witnesses.

Experiments made in the New York Aquarium lead to the conclusion that such use is possible. Calculations as to the adhesive power of the disk show that the adhesion is ample to effect the cap-

ture of such prey as it is used to take. Lastly data adduced show that the fish can endure the strain necessary to the "playing" and pulling in of the fish or turtle.

The paper was illustrated by all the known figures showing this use of this fish. The completed paper will be published shortly.

Reproduction In Cyclops. FANNIE E. VANN.

Several experiments were carried on in rain water, filtered pond water, distilled water, and sterile pond water as media which were free from unattached eggs and larvæ, during the months of April, May, December, 1918, January, February, March, April and May, 1919. Some of the experiments were run in glass standers, and others in egg shells as containers. Our conclusions were: (1) Egg production and hatching occur the year round (with summer results to be determined); (2) mature individuals producing eggs are produced from March, April, and May hatched larvæ; (3) the best culture medium is filtered pond water; and (4) that the best container is a membraneous vessel placed in a bowl of "native" water. Illustrated by lantern.

Deposits of Volcanic Ash. JOHN E. SMITH.

(Read by Title)

In the United States these deposits may be divided into three groups: (1) surface deposits, those at or near the surface which enter into the composition of the soil; (2) bedded deposits, at some depth used chiefly as a source of abrasive material for scouring soaps and polishing powders; and (3) indurated deposits, tuffs now weathering to soil as in the southern Piedmont belt.

Deposits of volcanic ash occur abundantly in the Rocky Mountain region and westward. In Texas, the deposits extend eastward to an area only a few counties distant from the Gulf. In Oklahoma, they reach nearly to the Arkansas boundary; in Missouri, glass, doubtless of this origin, has been identified in the soil; and in Nebraska, volcanic ash is reported to be present in nearly every county in the state. It is found also in South Dakota and Montana. Thruout the Plains region in some of the deposits, ash is mixed with stratified clay which is evidence that it fell into water. This water was certainly fresh in western Nebraska and probably elsewhere.

The eruptions of Mt. Katmai, Alaska, in 1912, of Krakatoa, Sunda Islands, in 1883 and of various other mountains have proved that volcanic ash is sometimes deposited in beds of considerable thickness a hundred miles or more from its source. In the Great Plains region of the United States, the deposits of this material are thicker and its texture coarser toward the west and thinner and finer respectively toward the east which indicates an origin in the region of the Rocky Mountains. In age they range from the Oligocene to the Pleistocene and later.

Examples of indurated tuffs occur in Michigan, Massachusetts and North Carolina among the Pre-Cambrian rocks labeled in museums with such names as petrosilex, hornfels and novaculite and also among those called flint-like slates and silicified tuffs by some writers.

Recent Mosquito Control Work in North Carolina. R. W. LEIBY.

Brief outline of diseases known to be transmitted by mosquitoes, with emphasis upon those occurring in North Carolina. Resumé of control work done in North Carolina with account of antimalarial operations at Wilmington, N. C. Illustrated with lantern slides and motion pictures.

Some Notes On Protozoa. BERT CUNNINGHAM.

(*a*) The occurrence of *Tintinnus serratus* Kofoid, in Chesapeake Bay, is printed in full elsewhere in this JOURNAL. *(b) Arcella excavata*, nov. sp., most nearly resembles *A. curvata* Wailes, but is characteristically different. Illustrated by lantern.

The Ovary of the Gaff-Topsail Catfish, Felichthys felis. E. W. GUDGER.

This organ is composed of two sacs separate in front but united posteriorly to form a common oviduct opening on the genital papilla. The walls of the posterior or oviducal third lie in parallel ridges to allow for the distention necessary in the passage of the great eggs averaging 20 mm. in diameter. These ridges decrease in height

anteriorly and in the middle third of the organ become covered with small eggs which never become functional. The anterior third of each ovisac is the functional ovary and its walls are lined with huge eggs each in its follicular sac attached to the wall of the ovary by a long pedicel.

This paper, which was illustrated by drawings and photographs, will shortly be published by the Carnegie Institution of Washington.

A Parasitic Blue-Green Alga. W. C. COKER.

In April of last year we collected in a ditch at the Golf Links near Wilmington, N. C., a species of Saprolegnia that I am treating as a form of *S. anisospora* DeBary. Cultures made in the ditch water with Alga, etc., in which the species was taken showed a remarkable abnormality. A good many of the oogonia were much swollen to as much as twice the average size, while the eggs, which were no greater in number than usual, were in great part disorganized, often only one or two maturing. The disorganized eggs would usually reach the point of forming a thin wall, and would then go to pieces inside. This condition was not thoroughly realized until after the culture had been purified on agar and the abnormality thus arrested. It was then found from slides that the enlarged oogonia contained a parasitic organism with the exact appearance of a blue-green alga, which ran among the eggs. There was not the least resemblance to the ordinary fungal parasites that attack the Saprolegnias, and it is to be regretted that the parasite was lost before it could be more thoroughly studied.

Investigations of the Nitrotoluenes. JAMES M. BELL.

The four principal products of nitration of toluene are o-nitrotoluene, p-nitrotoluene, 1-2-4 dinitrotoluene and 1-2-4-6 trinitrotoluene. All of these are of interest in the manufacture of explosives and of dyes. As the analysis of mixtures of these by ordinary chemical methods is impossible, indirect methods of analysis only can give the composition of such mixtures. A method of finding compositions of binary mixtures and of ternary mixtures of the last three nitro-

toluenes mentioned above was obtained by studying their melting points and by mapping the results by means of triangular coördinates. The results will be printed in full in a later number of the Journal.

New Naphthalene Dyes. A. S. WHEELER.

Juglone is a compound known for over fifty years to be present in walnut hulls. These hulls as well as other parts of the walnut tree may be used to produce a rich brown dye and have long been so used by the farmer's wife. The exact character of the dye is not known, but most likely is a near derivative of juglone. The latter compound may be synthesized from naphthalene. Another name for it is 5-hydroxynaphthoquinone. The halogen derivatives of such compounds have been very little studied. If juglone is chlorinated or brominated in the cold unstable addition products are obtained, but these are readily converted by the action of alcohol into stable monosubstitution products. If juglone is chlorinated or brominated in hot solution stable higher halogenated substitution products are obtained. All of the stable products act as dyes since they contain a chromophore as well as an auxochrome group. Owing to the presence of the phenolic hydroxyl group they form easily soluble sodium salts, practical for purposes of dying. The tribromojuglone imparts a champagne color to silk, a tan color to wool and this may be changed to various tints by the use of mordants. Cotton is not affected unless mordanted with tannic acid. Dichlorojuglone gives a rich bronze color to silk and the hydroxydibromo-juglone a delicate lavender which is markedly changed by mordants. Other dyes are being prepared in this field and a patent to cover all has been applied for.

The following papers appear elsewhere in this issue of this Journal.

A Portable Printing Press for the Ecologist. Z. P. METCALF.

Some Generic Distinctions in Sponges. H. V. WILSON.

Our Rats, Mice, and Shrews. C. S. BRIMLEY.

Reptilian Folklore. C. S. BRIMLEY.

The Distribution of Rhododendron Catawbiense, with Remarks on a New Form. W. C. COKER.

For the following papers no abstracts have been received:

Undamped Electrical Oscillations. C. W. EDWARDS.

Sanitation in the South. THORNDIKE SAVILLE.

A Magnetic Paradox. F. N. EGERTON, JR.

Vegetation in the Closing of Ponds with Special Reference to the Kamaplain Ponds of Wexford County, Michigan (Lantern). COLLIER COBB and H. D. HOUSE.

Asymmetry in the Formation of the Nervous System of the Frog Embryo. BLACKWELL MARKHAM.

New and Little Known Diatoms from Beaufort, North Carolina (Lantern). J. J. WOLFE.

The Seventeen-year Locust in North Carolina in 1919. Z. P. Metcalf.

The High Frequency Electric Furnace. F. N. EGERTON, JR.

The Felsites of Mount Collier. JOHN E. SMITH. (Read by Title.)

The Inland Waterway from Boston to Beaufort. COLLIER COBB.

Location of Invisible Objects. C. C. HATLEY.

BERT CUNNINGHAM, *Secretary.*

NOTES ON OCCURRENCE OF *TINTINNUS SERRATUS* IN CHESAPEAKE BAY

By Bert Cunningham

The genus Tintinnus was first named by Shrank. By Dujardin and Perty it is not considered good. It is held as good by Kent, Duc 'd Orleans, Pritchard, Claparede and Lachman.

The species *serratus* was named by Kofoid[1] in 1905, the individuals being taken "inside the kelp belt off San Diego in June."

The writer has found this species in the Plankton Collections taken by the United States Bureau of Fisheries in Chesapeake Bay during the years 1915–1916.

The similarity of form may be seen from the following comparisons (Table 1):

TABLE 1.

	Pacific Form	Atlantic Form
Length	150μ	150μ
Diameter A	18μ	18μ
Oral Ap. Dia.	25μ	20-22μ
Diameter P	15μ	15μ
Teeth	20	about 20

Kofoid gives the number of teeth as 20. In the material examined by the writer the number was estimated as 20, before access was had to the Kofoid's paper.

The collections of the Bureau were made more or less throughout the year and the following tables are taken from the data which is involved in the report of the Plankton investigation.[2]

[1]Kofoid C. A. Some New Tintinnidæ from the Plankton of the San Diego Region, Univ. of Cal. Pub. Vol. 1, No. 9. July, 1905.
[2]The report of this plankton work has not yet been published.

The yearly occurrence is shown in the following Table:

TABLE 2.

Area	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A	C	N	C	C	N	C	40	N	600	C	N	N
F	C	N	40	C	N	C	C	N	200	N	N	N
J	C	N	C	C	N	40	120	N	200	C	N	C
L	N	N	C	C	N	N	40	N	N	N	N	C
M	C	N	C	N	N	C	C	N	80	C	N	C
P	N	N	C	C	N	N	40	N	C	40	N	C
R	C	N	N	N	N	C	80	N	N	C	N	C
X	C	N	C	C	N	40	C	N	120	N	N	C

Explanation of Table 2.

c—collection taken but *T. serratus* not found.
n—no collection taken.
The numbers indicate the individuals per liter, based upon the counting of .25 cc. of sea water. Areas indicate definite locations.

The occurrence is always on the surface except in one case, where it occurred in 9 meters of water and only one individual was found in 25 cc. of sea water.

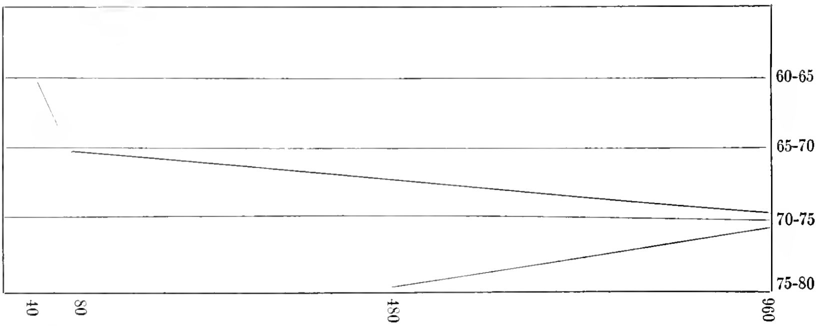
Though the organism occurs also in March, June, July and October, the maximum occurrence is in September.

A study of the temperature relations shows that while the organism has a range from 38.7° to 78.5° that the optimum lies from 70°–75°. The temperature data is tabulated in Table 3 and a graph is shown in Table 4.

TABLE 3.

AREA	Col. No.	Date	Temp.	Organisms
A	8599 8682	July 26 Sept. 9	75.8 74.1	40 600
F	8461 8684	Mar. 6 Sept. 12	38.7 72.5	40 160
J	8566 8608	June 11 July 27	68.2 78.5	40 120
J L	8671 8615	Sept. 10 July 28	75.3 78.2	160 40
M P	8668 8349	Sept. 10 Oct. 25	74.8 63.5	80 40
P	8614 8665	July 28 Sept. 10	78.4 74.5	40 0 (?)
R X	8618 8584	July 30 June 12	77.4 66.5	80 40
X	8657	Sept. 9	75.0	120

TABLE 4.



The rareness of the occurrence may perhaps be better understood when we realize that the numbers in these tables indicate the calculated number per liter, while the number actually observed was 1/40 of this. It is further shown by a comparison of the number of these with the total number of organisms in the collection. The best ratio is 1:125, while the average is 1/350.

There is insufficient data concerning the tides to determine whether this is an ocean or bay form.

ON SOME GENERIC DISTINCTIONS IN SPONGES.

By H. V. Wilson

Genus Tetilla O. Schmidt 1868. Suborder Sigmatotetraxonida. Tribe Sigmatophora. Family Tetillidae.

Tetilla O. Schmidt+Chrotella Sollas, Sollas 1888.

Tetilla O. Schm., Lendenfeld 1903.

Tethya Lamarck, *pars*, Lendenfeld 1906.

Typically the ectosome is not a distinct layer but shades off into the choanosome; the pores and oscula scattered, and not located in special depressions. In some species, however, the ectosome is to some extent histologically differentiated and partially assumes the character of a fibrous cortex, thus constituting an approach to Tethya. And in some species there are special depressions, on the smooth floor of which numerous small apertures (afferent pores or small oscula or both?) are located; these species in respect to this feature, ranging over towards Cinachyra. There is no special cortical skeleton. The microscleres have been lost in some species.

Lendenfeld, 1906, merges Tetilla in Tethya (Craniella *auct.*) and hence changes the family name to Tethydae. As I have elsewhere said (George & Wilson, Sponges of Beaufort Harbor and vicinity), it seems best to retain both genera, and the family name (Tetillidae) may be left unchanged.

Tetilla, the simplest and therefore presumably the ancestral genus of the family, has been gradually enlarged in the practice of recent writers by the incorporation in it of atypical species that depart in one direction or another from the central group of typical forms to which Sollas' definition (1888) is applicable. Thus species that have differentiated in the direction of Tethya, in that they have a fibrous cortex, are here included (*T. longipilis* Topsent 1904; *T. anomala* Dendy 1905; *T. borodensis* Dendy 1916). Other species are classed here that have differentiated toward Cinachyra in that there are superficial poriferous depressions, the floor of which exhibits pore-like apertures, the inhalent or exhalent nature of which seems not to be certain (cf. Kirkpatrick 1905, Dendy 1905), but these species lack the fibrous cortex and cortical skeleton of Cinachyra

(*T.hirsuta* Dendy 1889, 1905; *T.limicola* Dendy 1905; *T.cinachyroides* Hentschel 1911).

Tetilla and its relatives offer excellent illustrations of the fact that sponge genera become more and more difficult to distinguish as the number of known species increases, and I venture to set down some reflections on this matter.

Each genus is, of course, only a group that has been gradually built up round a type embodying a certain combination of well-marked features or "characters." In the cases of the related genera Tetilla, Tethya, and Cinachyra, the main "characters," grouped (Mendel-wise) in pairs the members of which contrast, are as follows:

1. A non-fibrous cortex (*a*), or a fibrous cortex (*A*).
2. Radiating cortical spicules not present (*b*), or present (*B*).
3. Pores scattered (*c*), or grouped in poriferous depressions (*C*).

Of these characters Tetilla typically embodies *a, b,* and *c;* Tethya, *A, B,* and *c;* Cinachyra, *A, B,* and *C.*

Comparison of related sponge species indicates that the characters vary, more properly *have* varied during the evolution of the present races, independently of one another, and hence the number of combinations actually found increases with the number of species that come to be known in a genus. In the case of the above group of forms there are more combinations than there are recognized genera, and this is, of course, often the case in systematics. Thus among the species congregated under Tetilla, we find not only the typical combination but others as well: *A, b,* and *c; a, b,* and *C.*

In such a state of affairs we may either combine genera until we get groups so heterogeneous as to be useless to biology, or we can go on splitting up genera on the plan that each genus shall represent only a particular combination. Thus, on this idea, it would be logical to divide the species, now grouped under Tetilla, into three genera.

But another difficulty faces us here in that the extremes of a character, the sharply contrasting conditions that constitute the members of a pair, are so often connected by intergrades. Thus in Tetilla, between non-fibrous cortex and fibrous cortex there are many intergrades. And it may confidently be said that the more intensive

grows the study of a group of species, the more of these intergrading series come to be known. Hence it may be expected that the characters above designated as *b* and *B*, will, like *a* and *A*, be found to intergrade, and *c* and *C* likewise, if indeed the recorded data do not already justify that conclusion.

In view of the common existence of intergrades between the contrasting members of a pair of generic characters (*a* and *A*, e.g.), it becomes in the end impossible to split sponges, organisms in general probably, into genera, each set of which shall represent a particular combination of characters.

What practice remains then for the classifier, who knows that without systematics, biological data in general cannot be recorded with any certainty that they will be found again, and who therefore must classify, but who does not wish to set up a system of categories which can be precisely defined *only because they are artificial*, and into which while some organisms go nicely, others can be brought only after a character is pared down in thought, or extended in thought? One way out, and as I have indicated above, the way into which we have fallen in the case of Tetilla, is to recognize large heterogeneous genera (Tetilla, e.g.) and other smaller, more homogeneous, ones. I cannot see at present any better way. It is certainly a preferable method, i.e., one that enables biologists to find the recorded data more successfully, than that of building up genera, all of which overlap extensively.

This contrast between small homogeneous genera and large heterogeneous ones is, like the contrast between homogeneous and heterogeneous species, perfectly well recognized and widely used in botany and zoölogy. Nevertheless the underlying idea is, I believe, not always appreciated in its full significance, and in such cases artificially defined groups continue to be made, with the single difference that they are called sub-genera instead of genera.

Of course, the division of a heterogeneous genus into subgenera is a useful practical method, but if it be assumed that every actual concrete organism can be put in some one of the neatly defined subgenera, we will be led astray from accurate observation and recording, since in respect to the differential characters intermediates exist.

We must recognize that precisely defined subgenera are ideas each of which is actually represented by perhaps only a few forms. Many other forms cluster round such central types in such wise as to be intermediate between them, sometimes intermediate between two types in respect to one character, and between two others in respect to another character.

All this militates against the making of too many systematic groups, because in the end, if the characters of the concrete organism are to be really recorded as they are, whatever groups are made, some qualifying statements will usually have to be added to the designation of the organism as of such and such a genus or subgenus.

I am making no plea for looseness of identification, far from it. But, incidentally at least, this paper does make a plea against attempting to define too precisely the place in nature of an organism through continued formation of new genera, or division of genera into subgenera. At any rate, the subgenus when used should be thought of, not so much as *a subdivision* but rather as one of several types within the genus, *subgeneric types,* standards as it were. Certain organisms will be found practically to conform to some one of these standards. While an organism that deviates can be briefly described by stating its differences from some standard.

Finally it may be pointed out that the relation of series, composed of intergrading members (viz., species of Tetilla, e.g., with cortex ranging from fibrous to non-fibrous) to the current Mendelian theory of germinal units is plain. If we assume enough units, the theory is applicable. But in thus enlarging the number to suit these facts, the Mendelian units or genes come to be synonymous with what we call hereditary properties. I mean the subtle, minute powers, many of which may act in concert to produce a sensible effect, the kind of germinal property which at its first appearance in the evolution of a race or strain we call a small heritable variation, when for instance we speak of the gradual summation of variations. In this way the gene is removed from its somewhat isolated position in biological thinking, and made available even to the systematist, who in adopting it, however, must also adopt Semon's contention[1] that all variation

[1] Richard Semon. Das Problem der Vererbung "Erworbener Eigenschaften," 1912.

is at bottom discontinuous, in other words, that quantitative differences are to be looked on as summations of minute unit differences.

That the Mendelian gene, whether or no it have a material, discrete body and a location in the germ substance, may be thought of somewhat in this way, has been pointed out by several, H. S. Jennings[2] and F. B. Sumner[3] among others. Sumner's facts and thinking, in the paper referred to, are of especial interest to zoölogists dealing with the classification of natural races, who would like to knit up systematics more closely with the study of variation and heredity. A quotation shows how close my own standpoint is to his in respect to certain points. In speaking of some mouse races, he sums up: "It is quite plain that these 'subspecies' have diverged from one another in respect to characters which have varied quite independently. There is no single graded series for all the characters—," *loc. cit.,* p. 205.

My proposition as to the use of subgenera in the case of large, heterogeneous genera is in accordance with the practice which is pursued at times by some systematists. The master-student of sponges, F. E. Schulze, in a parallel case, though one dealing with subspecies, thus marks out the treatment which he proposes for a horny sponge, *Hircinia variabilis.* In the first place he combines six recorded species, and then goes on to say "The older specific names of Schmidt, like *dendroides, flavescens,* may be employed as varietal names for *certain conspicuous combinations of characters* which frequently occur in particular localities, but *which are by no means constant.* Thus we may speak of a *Hircinia variabilis dendroides,* a *Hircinia variabilis flavescens,* etc. *But when a specimen does not conform to one of these types, we will have to designate it simply as Hircinia variabilis.*"[4] (Italics, except for names, mine.)

CHAPEL HILL, N. C.

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[2] H. S. Jennings 1917. Observed Changes in Hereditary Characters in relation to Evolution. Journ. Wash. Acad. Sci., Vol. VII.

[3] F. B. Sumner 1918. Continuous and Discontinuous Variations and their Inheritance in Peromyscus. Amer. Naturalist. 1918.

[4] F. E. Schulze 1879. Unters. ü. den Bau u. die Entw. d. Spongien VIII. Die Gattung Hircinia Nardo und Oligoceras *n. g.* Zeitschr. f. wiss. Zool. Bd. XXXIII, p. 11.

A PORTABLE PRINTING PRESS FOR THE ECOLOGIST

BY Z. P. METCALF

The writer has long regretted the deficiency of the present methods of labeling insects on pins. Usually one of two or three systems is followed. Either the labels are lettered by hand, a laborious and expensive process or the labels are printed by the printer. In the latter case one of two systems is usually followed. Either a general locality label is printed such as N. C. for North Carolina or labels are prepared for various separate places. It is not my purpose here to enter into a discussion of the geographical limits that must be established for any given locality. Practically speaking any insect taken within a collecting radius of a given town may be said to have been collected in that town. With this in mind labels should be used only for localities that are large enough to be found in a standard atlas. In the mountains elevations are often of importance and the writer long ago adapted the practice of trying to label things on the basis of 500 foot zones. Much other data may well be added to labels of specimens such as the day of the month, the month of the year and even the year, although the latter is frequently unnecessary. Some divide the month into three parts, early, mid and late and label their specimens accordingly, doing away with the day of the month entirely. I have omitted all reference to that well known, but to my mind reprehensible, system of giving specimens a catalog number and recording the data in a catalog. Such specimens are sure to get separated from their catalog and then the hidden meaning of the catalog is sure to haunt some one all his days. Frequently I have received a rare or interesting specimen labeled only with a catalog number when I would have given almost anything to know the real history of the specimen.

With all of these points in mind I was very much interested in a small hand stamp for printing pin labels in the office of Mr. H. S. Barber of the United States National Museum. The chief points about Mr. Barber's outfit that interested me were that he used a small metal holder in which the type was locked by means of a set

screw, that he used the regular printer's metal type, and that he used regular printer's ink. The further thought presented itself that if this was a good thing to have in an office why wouldn't it be a good thing to have a portable outfit to be carried into the field. Then the thought occurred to me that this thing ought to be useful to the general ecologist as well as the entomologist and thus in this round about way I have arrived at my reason for presenting this matter here. To discuss the subject briefly it may be divided into two parts: (1) the apparatus (2) the method of procedure.

My apparatus consists of a font of type, a type box, a compositor's roll, a tube of printer's ink, a bottle of benzine, a glass plate or two, a pair of forceps, and a type holder. The font of type may be of any size desired. Since the entomologist is interested in getting as much into as small a space as possible I use a $4\frac{1}{4}$ point type which is about one-half the size of ordinary book type and is about as small as can be used with ease. The type box I use is made with small compartments which are just a little wider than the type is high. My box contains 104 compartments because I use capitals, small capitals, lower case letters and a number of other characters. The box is made as tight as possible so that the type cannot become mixed in carrying it about. The lid of the box is lined with two sheets of blotting paper. Ink in a tube is much more convenient than in any other form as it remains much fresher and is more easily worked in this way. The benzine is used in mixing the ink and in cleaning the type. The compositor's roll is used to mix the ink also. The forceps are used to handle the small type, but may be dispensed with when using larger type. The type holder is a small brass box with a width slightly less than type height and with one side entirely wanting and the lid held in place by means of four set screws and with another set screw at one end of the box to hold the type in place. The box may be of any size and should be high enough to hold as many lines of type as we desire to print at one time and it should be long enough to hold all the characters we think we will ever use and then a few more for emergency. My box is high enough to hold four lines of $4\frac{1}{2}$ point type, about all one ever desires to put on a single pin label.

The method of using this apparatus is simplicity itself. The first step is setting the type. The type are selected one after another, starting with the top line and placing the characters in order in the bottom of the type box. It will be noticed that each character has a groove called the "nick" on one face of the type to distinguish the bottom of the character. If the characters are properly placed the nicks on all of the characters are towards the lid of the box and can be examined after each line is set to determine whether each character is in proper position or not. After all the characters are in proper position the lid is lightly fastened by means of the four set screws and a small block of wood with a true face is laid on the face of the type and they are brought into a flat surface by gently tapping with a hammer.

The next step is mixing the ink. The ink is squeezed from the tube onto a glass plate (old negatives are good). Benzine is added drop by drop and the two mixed together until the proper consistency is obtained. Getting just the proper consistency is apparently a matter of practice and experience. After the ink is properly mixed it is rolled up on the compositor's roll in the form of a thin film. The ink is taken from the roll by the type.

The last step is printing the label. For printing pin labels I like to have narrow strips of paper of just the proper width so that one label can be trimmed with each cut of the shears. Not every label printed by hand will be perfect but experience will soon teach the proper consistency of the ink, the amount of ink to be applied to the type, and the proper pressure to give the type on the paper. For printing by hand the paper should be placed on two or three sheets of blotting paper to counteract any unevenness in the face of the type.

Lastly for the advantages. A recent case in point will perhaps be better than anything else. Mr. R. C. McGregor recently sent me a lot of Homoptera from the Philippines collected as follows:

Culasi, Panay. May 24, May 30, June 15, July 15, July 24.
Tibiao, Panay. May 12, May 14. Manilla, August 26.

To have labeled all of these specimens by means of lettered labels would have been a very laborious process. To have had separate

labels printed for each locality would have been unnecessarily expensive. To print these labels by hand and place them on the 300 or more specimens was the work of about one-half hour all told. Certainly nothing very laborious or troublesome. An outfit such as I have described can be carried to any field station and any and all special labels printed neatly and rapidly.

CRATERELLUS, CANTHARELLUS AND RELATED GENERA IN NORTH CAROLINA; WITH A KEY TO THE GENERA OF GILL FUNGI*

By W. C. Coker

Key to the Genera of Agaricaceæ or Gill Fungi

A. Spores white or yellowish (except in forms of *Pleurotus sapidus* where they are lilac, in certain species of *Craterellus* and *Cantharellus* and *Tricholoma* where they are pinkish, and in *Lepiota Morgani* where they are greenish 1

1. Plants fleshy, soft, usually soon decaying; if dried not reviving well when moistened. (Some of the smaller species of *Collybia* approach very closely to *Marasmius* in texture and revive when moistened) 2

1. Plants leathery and toughish, pliable; if somewhat fleshy, then reviving and assuming their original shape when moistened after drying 16

1. Plant corky or woody, firm, laterally sessile on wood (shelving); cap hairy, concentrically zonate (placed under the *Polyporaceæ*, which are to be treated later) .... *Lenzites*

2. Plant growing on decaying mushrooms (*Russula*); gills thick with broad, blunt margins, or not rarely aborted .... *Nyctalis*

2. Plant growing on decaying leaves of rhododendron, very minute (less than 1 cm. high and 1 mm. broad), gills aborted or few and distant, hymenium dissolving .... *Eomycenella*

2. Plant not as above (if growing on other mushrooms the gills are not as in Nyctalis) 3

3. Spore-bearing surface (hymenium) smooth or obscurely veined towards the margin of the cap; plant funnel-shaped or with a spreading cap (in *C. Cantharellus* the spore surface is intermediate between this and the next genus) .... *Craterellus*

3. Hymenium composed of more or less gill-like plates or veins, but their margins blunt and anastomosing or branching; spores buff or ochraceous or pinkish .... *Cantharellus*

3. Hymenium composed of distinct gills, which are not fold-like or vein-like. (If the gills are thick with rather blunt margins, as in species of *Laccaria* and *Hygrophorus*, they do not anastomose freely and the spores are white) 4

4. Plants exuding a milky or colored juice when broken; flesh of cap composed in large part of globular cells and usually rather fragile. (The steam of some species of *Mycena* exudes a watery or colored juice, but the flesh is not composed of globular cells, and the plants are small and slender) .... *Lactarius*

*The colored plate was painted by my niece, Dorothy Coker. The spore plate was mostly drawn by Miss Alma Holland. The photographs are by me and except where indicated are natural size as is also the colored plate.

4. Plants not exuding a juice (except from the stems of certain species of *Mycena*) 5
5. Plants usually quite brittle, the flesh composed of globular cells; spores white, creamy or yellowish, mostly spherical and marked with spicules, warts, or ridges (rarely smooth)............*Russula*
5. Plants not as above in all respects................................. 6
6. Gills waxy and semi-translucent in appearance, usually thick and broadening towards the cap, the entire plant soft and usually fragile (The gills of *Laccaria* approach these in appearance, but the plants are tougher and less brittle)..................*Hygrophorus*
6. Gills not as above, or if nearly so then the plant tough and firm..... 7
7. Stem none, or, if present, not in the center of the cap (rare exceptions); plants mostly growing on wood................*Pleurotus*
7. Stem central or nearly so.. 8
8. Stem easily separating from the cap, both stem and cap fleshy; gills free or nearly so.. 9
8. Stem continuous with the cap, not easily separating.................10
9. Stem at base furnished with the remains of a volva, such as a cup or rings or warts or scales or meal (in a few species where these are regularly or at times absent the stem is distinctly bulbous); veil present and usually forming a ring on the stem; gills free or nearly so ....*Amanita*
9. Stem and gills as above, but veil (and ring) absent......*Amanitopsis*
9. Veil present and gills free or nearly so, but stem without remains of a volva ....*Lepiota*
10. Stem fleshy or fibrous and elastic, of the same texture as the cap....11
10. Stem cartilaginous, of a different texture from the cap..............14
11. Stem with a veil (and ring); volva wanting; plants densely clustered and growing from stumps or roots.....................*Armillaria*
11. Stem without a veil or volva.......................................12
12. Gills notched at the stem, i. e., attached but not by their whole width, and not decurrent...13
12. Gills decurrent, not sinuate (in a few species the gills are usually not decurrent, and they are sometimes various in this respect in the same plant, as in *C. tumulosa*. In *C. dealbata* they are squarely adnate or even a little notched at the stem as in *Tricholoma*, and in *C. nebularis* they are usually squarely attached)..........*Clitocybe*
13. Gills thick with blunt edges, purplish or pinkish at all ages, but becoming conspicuously dusted by the white spores; stem toughish and fibrous ....*Laccaria*
13. Gills thin, variously colored (if pinkish then turning color when bruised or in age); stem fleshy.......................*Tricholoma*
14. Gills decurrent ....*Omphalia*
14. Gills not decurrent, or barely so..................................15
15. Margin of cap inrolled when young........................*Collybia*
15. Margin not inrolled when young, plants small.............*Mycena*

16. Gills split along the edge into two plates which roll outward when dry; plant sessile on wood............................*Schizophyllum*
16. Gills not as above..17
17. Stem easily separating from the cap, central; cap toughish-leathery, thin, reviving to its original shape when moistened after drying, usually small and growing on wood....................*Marasmius*
17. Stem continuous with the cap or none, not separating easily, all growing on wood...18
18. Gills blunt on the margin, fold-like and irregular; plants small, reviving when moistened, small, laterally sessile or hanging......*Trogia*
18. Gills not as above..19
19. Gills toothed on the edge................................*Lentinus*
19. Gills not toothed on the edge...............................*Panus*

B. Spores rosy pink or salmon, or flesh color, or brownish pink or ochraceous pink or pinkish brick-color, or chestnut; and in most species the spores are irregularly angular or warted. In some (as *Claudopus variabilis*) the spore color is exactly intermediate between the typical pinkish color of this section and the ochraceous color of the next. The presence of any pink tint will indicate this group. Veil absent; a volva present only in *Volvaria.*

1. Stem lateral or none; growing on wood................*Claudopus*
1. Stem central 2
2. Stem readily separating from the cap; gills free................... 3
2. Stem and cap of the same texture and not separating without tearing up; gills attached or almost free............................... 4
3. Stem with a cup-like volva at the base....................*Volvaria*
3. Stem without a volva......................................*Pluteus*
4. Gills sinuate (notched at stem) or almost free, or squarely attached and with a slightly decurrent tooth in some cases (distinctly decurrent only in *Leptonia formosa* var.)............................ 5
4. Gills decurrent 7
5. Stem fleshy to fibrous...................................*Entoloma*
5. Stem with the texture of cartilage.............................. 6
6. Margin incurved when young...........................*Leptonia*
6. Margin straight even when young........................*Nolanea*
7. Stem fleshy to fibrous.....................................*Clitopilus*
7. Stem with the texture of cartilage.........................*Eccilia*

C. Spores ochraceous, or rust color, or rusty-brown or dingy vinaceous-brown; the gills more or less similarly colored at maturity. (Certain species of Russula, a genus placed in the white spored group, have decidedly ochraceous or yellow spores, but these may be distinguished by the fragile-brittle texture due to the globular cells that make up the flesh of the cap.)

1. Gills usually separating with ease from the cap, veined between, usually anastomosing or forking; cap margin always inrolled ....*Paxillus*

1. Gills not as above; veil absent........................*Plicaturella*
1. Gills not as above; veil present.................................. 2
2. Veil composed of cob-web hairs (arachnoid), often invisible in age ....*Cortinarius*
2. Veil not cobwebby.. 3
3. Stem eccentric or none..............................*Crepidotus*
3. Stem central 4
4. Stem with a ring..*Pholiota*
4. Stem without a ring.. 5
5. Gills dissolving into a jelly or powder....................*Bolbitius*
5. Gills not as above.. 6
6. Gills free from the stem..................................*Pluteolus*
6. Gills attached to the stem (adnate or adnexed).................... 7
7. Stem fleshy 8
7. Stem cartilaginous 10
8. Gills usually notched at the stem (sinuate)........................ 9
8. Gills squarely attached (adnate) or decurrent...........*Flammula*
9. Cap scaly or fibrous or silky*.............................*Inocybe*
9. Cap smooth, viscid.......................................*Hebeloma*
10. Gills decurrent ....*Tuleoria* [not represented]
10. Gills not decurrent...11
11. Cap margin inrolled when young at least.................*Naucoria*
11. Cap margin straight even when young....................*Galerula*

D. Spores dark-brown or brown with a tint of purple or deep smoky purple (nearly black); usually umber-brown (sepia) or purple-brown in purplish chestnut.
1. Stem easily separating from the cap; ring present.........*Agaricus*
1. Stem not easily separating from the cap............................ 2
2. Veil present; ring present or wanting............................... 3
2. Veil wanting 4
3. Stem with a distinct ring..............................*Stropharia*
3. Stem usually without a ring; the veil hanging in tatters from the cap margin or disappearing early. (In *H. lachrymabundum* a ring is often present)....................................*Hypholoma*
4. Stem toughish-cartilaginous, hollow; margin of cap incurved when young ....*Psilocybe*
4. Stem as above or more fragile, hollow; margin of cap straight when young ....*Psathyra*

E. Spores black or nearly so, not purplish (deep smoky olive in *Gomphidius vinicola;* and in a few species of *Corprinus* they are deep brown, as in *Agaricus*, when fresh and moist, but turn almost black on drying).

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*In a few species of Inocybe that are nearly smooth such as *I. fallax*, the warty spores will distinguish them from Hebeloma.

1. Gills and margin of cap usually resolving into an inky fluid; if not, then the cap very thin and splitting or curling backwards .... *Coprinus*
1. Gills or cap not as above 2
2. Ring present .... *Anelaria*
2. Ring absent 3
3. Gills distinctly decurrent .... *Gomphidius*
3. Gills not decurrent 4
4. Cap membranous, its margin distinctly striate, at least when moist .... *Psathyrella*
4. Cap somewhat fleshy; margin not distinctly furrowed.... *Panæolus*

EOMYCENELLA

This genus has been proposed by Dr. Atkinson to contain a wonderfully delicate little plant found by him at Blowing Rock, N. C. His description follows: Atkinson (Bot. Gaz. **34**: 37. 1902).

"Plants stipitate. Pileus companulate to expanded, consisting of a layer of radiating branched threads forming a more or less lattice-like or trabecular, expanded, thin structure; trama wanting or very rudimentary the subhymenium arising directly from the trabeculæ of the pileus. Hymenium plane, or in larger forms with a few short, narrow, distant lamellæ not reaching the stipe; lamellæ with rudimentary trama. Basidia clavate, 4-spored. Spores smooth, 1-celled, hyaline. Stipe fleshy, delicate. At maturity hymenium dissolving, leaving many of the spores lying on an amorphous layer against the trabeculæ.

One species, on decaying leaves of *Rhododendron maximum*, Blowing Rock, N. C."

Eomycenella Echinocephala Atk.

This minute plant is included here because it is known only from North Carolina and because of its scientific interest to the student of mycology. The following description is also by Dr. Atkinson.

"Plants white, 3-8 mm. high. Pileus 0.5-0.75 mm. broad. Stipe 60-80μ in diameter. Plants campanulate to expanded and upturned in age, trabeculæ of upper surface echinulate, bearing here and there globose free branches, 10-15μ in diameter and also echinlate, margin of pileus with free clavate branches in the form of a fringe. Cells of the trabeculæ 25-30 x 6-10μ. Hymenium plane or with few short, narrow gills. Gills when present narrowed at each end, not reaching

the stipe. In the plant observed, 8 to 10 long lamellæ, 4 to 6 intermediate ones much shorter. Subhymenium loosely branched, obovate cells arising from the trabeculæ and terminating in the basidia, or in the forms with lamellæ arising from a rudimentary trama in the lamella. Basidia short clavate, abruptly narrowed into a pedicel, 9-12 x 6-9μ, 4-spored. Spores obovate-oblong, elliptical, proximal end pointed, 6-8 x 3-4 u, hyaline, smooth, granular. Stipe thread-like, with scattered hairs bearing a short echinulate cell on the end. Base of stipe only slightly broadened.

Eomycenella is related to Discocyphella[2] P. Hennings, but differs in the dissolving hymenium and the fact that the pileus is not gelatinous nor the stem horny. From Cymetella[3] Patouillard (placed with Agaricaceæ) it differs in the trabecular pileus and the dissolving hymenium; and from Glœocephala[4] (Clarvariaceæ) Massee, which has one-spored basidia. The latter should be placed in the Thelephoraceæ."

TROGIA

Plants small, growing on wood, laterally sessile, tough, persistent, reviving when wet; margin regularly lobed; gills fold-like; spores white.

We have but one species which we insert from records by Schweinitz and Curtis, as we have not found it.

Trogia crispa Fr.

The following is from Murrill (N. Am. Flora, **9**: 164. 1910 (as Plicatura):

"Pilei crowded, subimbricate, usually sessile, persisting, reviving when moistened, 1-2 cm. broad; surface reddish-yellow or tan, paler toward the margin, often whitish-villose when young; margin beautifully lobed: context fleshy membranaceous, tough, thin, white: lamellæ white, narrow, vein-like, irregular, continuous or interrupted, sometimes branched, edges crisped, obtuse, white or bluish gray: spores cylindric, smooth, hyaline, 4 x 1μ:"

Rare on alder twigs, etc. Schw. (Syn. Car. No. 837.)

Middle and upper districts, dead wood and sticks (as *Cantharellus crispus*). Curtis.

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[2]Engler and Prantl, Pflanzenfamilien I: 554.
[3]Ibid p. 555.
[4]Ibid. p. 131.

NYCTALIS

Plants growing on other mushrooms; small; cap mealy from the conidiospores; gills thick with blunt margins, or often fold-like or even aborted; veil not noticeable.

We have but one species.

Nyctalis asterophora Fr.

PLATES 2, 3 AND 16.

This remarkable plant is found occasionally growing in clusters on decaying plants of *Russula nigricans*. The caps are almost hemispheric and remain so at all ages, the margin strongly inrolled. They are up to about 3.8 cm. wide, white at first then grayish-buff and finally nearly buff, the surface tomentose-looking and soon becoming mealy from the loose coating of conidiospores that cover it.

Stem about 3-6 cm. long, and up to 6 mm. thick at top, tapering downward, white at first, then changing color more or less like the cap; usually crooked and irregular.

Gills very often aborted, when present they are thick, distant and narrow, with a blunt margin. Spores from the gills have been recorded, but usually seem to be suppressed, the reproduction depending on the conidiospores from the cap surface. These last are quite irregular in shape and size, usually longer than broad, more or less thickly covered with warty nodules, size about 14-19 x 18-26μ counting the warts. These conidiospores have been shown by Brefeld to be capable of reproducing the plant.

Illustrations: Mycologia **6**: Pl. 129. 1914.
Kauffman Agar. of Mich. **2**: Pl. 1. 1918.

1789. On a rotting *Russula nigricans*, pine grove at top of Lone Pine Hill, September 12, 1915. Photo and drawing of conidiospores.
2366. On rotting mushroom near Meeting of the Waters branch, by middle path, July 5, 1916. Photo.
2383. On dying *Russula nigricans*, base of Lone Pine Hill, June 28, 1916.

Asheville. Beardslee.
Middle and upper districts, on rotten agarics. Curtis.

PLATE 2

NYCTALIS ASTEROPHORA, No. 236

PLATE 3

NYCTALIS ASTEROPHORA ON RUSSULA NIGRICANS No. 1789

CRATERELLUS

Plants upright, fleshy, funnel shaped or rarely fan shaped, hymenium on outside, smooth or more often rugosely wrinkled at least towards the margin. The genus is to all appearances so closely related to *Cantharellus* that I do not think that we are justified in placing one genus in the *Thelophoraceæ* and the other in the *Agaricaceæ* as is practiced at present. So close is the relationship in fact that it is doubtful if the two genera can be logically separated. Some species, as the one I have treated here as *Cantharellus clavatus*, are so intermediate as to be placed in *Cantharellus* by some authors and in *Craterellus* by others. *Craterellus cantharellus* has not only the same shape and general appearance of *Cantharellus cibarius*, but also the same fragrance; while the spores of *Cantharellus aurantiacus* and *C. cinnabarinus* are pink like the spores of *Craterellus cantharellus*. If the folds of the hymenium are more or less distinct gills the species should be looked for in *Cantharellus*, if only wrinkled or rugose or smooth it should be found in *Craterellus*. As *Craterellus* is related on the one side to *Cantharellus*, so it approaches *Clavaria* on the other, and club shaped forms may be placed in either genus by different authors. These complicated relationships emphasize the impossibility of placing all related groups in juxtaposition in a lineal arrangement of genera. For full treatment of the genus see Burt, Ann. Mo. Bot. Garden **1**: 327. 1914. Also see Peck, N. Y. St. Mus. Bull. **2**: 44. 1887.

KEY TO THE SPECIES OF CRATERELLUS

Plant rosy on dorsal surface, hymenium and stem
  white .... *C. roseus* (3)
Plant entirely egg yellow.
  Stem solid .... *C. cantharellus* (1)
  Stem hollow .... *C. odoratus* (2)
Not entirely egg yellow or rosy.
  Plant tubular, with cavity to or near the base.
    Cap and stem drab when fresh, darker smoky-drab when old; pubescence at base of stem not
      buffy .... *C. cornucopoides* (4)
    Cap drying to leather color or snuff-brown, base
      with buffy pubescence.......................... *C. ochrosporus* (5)
  Plant less tubular, yellowish-brown to fuscous,
    1.5-3 cm. wide, hymenium and stem yellow...... *C. lutescens* (6)
  Plant less than 1 cm. wide, hymenium creamy-
    buff .... *C. calyculus* (7)

1. **Craterellus cantharellus** Schw.

PLATES 4, 5 AND 16.

Plants medium to large, gregarious, often cespitose, firm and solid, growing in low woods and in swamps; not common. Cap up to 14 cm. wide, slightly or rather strongly depressed in center at maturity, the margin uplifted and arched, strongly sinuate or lobed; surface smooth, even, dry, about egg yellow. Flesh thick, firm, with the fragrance of *Cantharellus cibarius.*

Hymenium varying from quite smooth to distinctly rugose-wrinkled over most of the surface, the very margin nearly always slightly rugose at least, the wrinkles anastomosing; color distinctly salmon.

Stem up to about 6 cm. long, expanding upward into the cap, always bent, surface smooth, texture solid and quite firm.

Spores (of No. 1157) a distinct and pretty salmon pink, elliptic, smooth, 4-4.5 x 5-8μ*.

In Ann. Mo. Bot. Garden **1**: 330. 1914, Burt remarks:

"This species is so similar to *Cantharellus cibarius* in habit, coloration, size and form—differing from the latter only in the more even hymenium—that figures of *C. cibarius* will serve very well for *Craterellus Cantharellus*, if allowance is made for the different hymenium. The firm and solid stem of *C. Cantharellus* distinguishes this species from *C. odoratus* easily."

1157. Low grounds of New Hope Creek, about 200 yards below bridge on Durham road, July 18, 1914. Photo.

In this collection of many fine plants the largest was 12.5 cm. high and 14 cm. wide. The venation was confined to about 2 cm. of the margin except in the very largest plants and in no case did the veins extend to the stem (see photo).

1584. Same spot as No. 1157 and just like that collection only smaller, June 26, 1915. Spore surface almost smooth.

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*In N. Y. St. Mus. Bull. 1, No. 2, p. 47, Peck says: "The spores . . . have a yellowish or salmon-yellow tint."

PLATE 4

CRATERELLUS CANTHARELLUS. No. 1157

PLATE 5

CRATERELLUS CANTHARELLUS, No. 1157

1600. Near branch west of Meeting of the Waters, not far from "Judge's Spring," July 13, 1915.

Blowing Rock. Atkinson.
Asheville. Beardslee.
North Carolina. Schweinitz.

2. Craterellus odoratus Schw.

PLATES 6 AND 16.

A peculiar plant with numerous small, funnel-shaped caps arising from a common solid stem; entire plant 5.5-7.5 cm. high, up to 7 cm. wide above; stem sometimes distinct, about 2 cm. long and 1.5 cm. thick, creamy white to ochraceous, glabrous, somewhat pitted and channeled, solid, firm, sometimes disappearing in a fused mass; flesh color of surface. Caps arising in all directions from the top of the stem, varying from very small up to 3.5 cm. long and 3 cm. wide, prettily trumpet-shaped, the margin crimped and wavy, narrowed below and hollow to the base, upper (inner) surface a beautiful chrome yellow (about deep chrome of Ridgway), finely *floccose-tomentose;* hymenium salmon-pink, quite smooth; flesh light yellow, about 1.3 mm. thick; taste and odor exactly that of *Cantharellus cibarius.*

Spores ochraceous-yellow, elliptic, smooth, many bent, 3.7-4.8 x 7.4-10.3μ.

I take our plant to be a much-branched form of *C. odoratus,* al though other descriptions do not mention the floccose-tomentose sur face. (See Burt, loc. cit., p. 331.)

Under the name of *Cantharellus odoratus* No. 1288, Curtis refers to this species in the Curtis-Berkeley Mss. as follows:

"Light yellow, very smooth, and destitute of plicæ, outer surface glaucous, 1-2 in. high, infundibuliform, hollow to the base of the stipe. Sporidia white. Sides of banks in woods."

2408. Mixed woods west of Meeting of the Waters, July 20, 1916. Photo.
2642. In path, low damp woods by branch back of athletic field, July 11, 1917.
2701. Rich woods, Battle's Park, July 16, 1917.
2761. Mixed woods north of cemetery, July 24, 1917. Photo.

Salem. Schweinitz.
Low and middle earth in woods. Curtis.

3. **Craterellus roseus** Fr.

This species is known only from the original collection by Schweinitz, probably near Salem. The description below is taken from Burt, (Ann. Mo. Bot. Garden **1**: 333. 1914):

"Fructifications solitary, somewhat fleshy; pileus infundibuliform, somewhat strigose, pallid rose, the margin lobed and inflexed; stem apparently stuffed, attenuated downward, white; hymenium somewhat rugose, white.

"In mosses, especially in proximity to *Kalmia*. North Carolina.

"Specimens of this species have the habit of *Cantharellus cibarius* but are thinner. Fries received a specimen of *Craterellus roseus* from Schweinitz and expressed the opinion in 'Elenchus' that the species is good. I have seen no specimens of *C. roseus* and base the above on the original description and the comments by Schweinitz and Fries."

4. **Craterellus cornucopioides** L.

PLATES 1 AND 16.

Plants up to 12 cm. tall and 5.5 cm. broad, shaped like a long cornucopia and hollow to the base, the margin broadly drooping or rarely plane, wavy, upper and inner surface squamulose-fibrous, most so near the margin, color exactly drab to light drab of Ridgway, blackening on drying. Flesh very thin, tough and elastic, color of surface, odor distinctly musty-fragrant, faintly like that of *Cantharellus cibarius*, taste slight, similar.

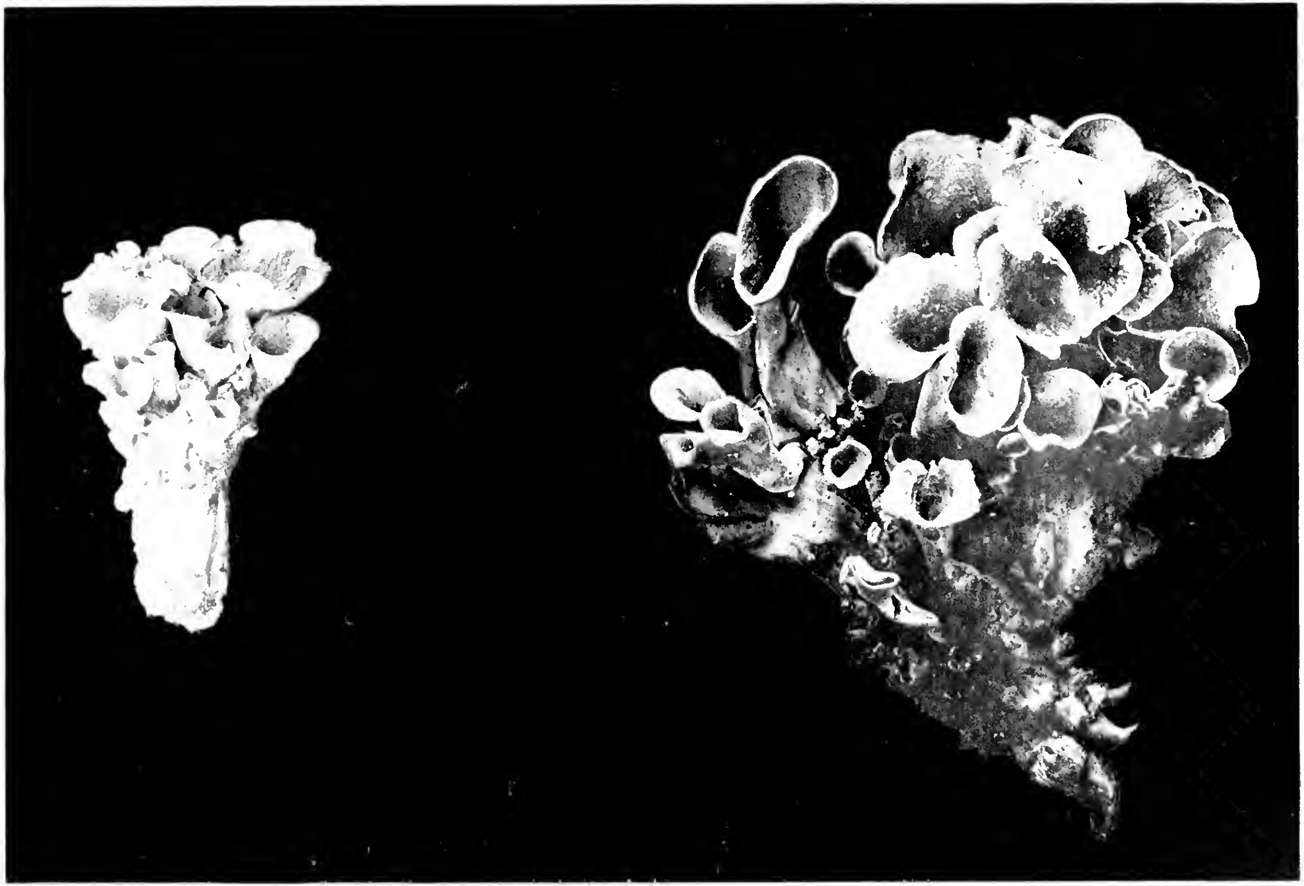
Spore surface glaucous, fleshy-drab color, not at all veined, but somewhat channeled and pitted or quite smooth in places, extending half way down the stem, or farther.

Stem fading into the cap, grayish drab, the base lighter and tomentose, not ochraceous below the hymenium, hollowed to the base, usually bent and pinched.

Spores a distinct salmon-pink color, elliptic, smooth, some bent, 5.9-7.4 x 10.8-13μ.

When rubbed and in age all parts become darker and sometimes quite black in places, but when perfectly fresh the colors are lighter than usually described. Descriptions of the spores as white or hya-

PLATE 6



CRATERELLUS ODORATUS, No. 2408 (left), No. 2761 (right)

line must have been made from old prints after the spores had faded, as they are distinctly a clear salmon-pink when at all fresh.

2195. Mixed woods, pasture near Mr. Pritchard's, June 22, 1916. Photo.
2536. In moss in damp woods back of athletic field, June 20, 1917.
3261. In moist, shady place among moss and liverworts in cemetery, May 30, 1909. Painting.

Asheville. Beardslee.
North Carolina. Schweinitz.

5. **Craterellus ochrosporus** Burt.

Plants 3-4 cm. high, stalk 2-2.5 cm. long, smooth, and black except at base which is covered with a minute creamy-buff tomentum; hollow to base; above it expands rather suddenly to the funnel-shaped cap about 1-1.5 cm. wide, which is brown and rough squamulose on the upper (inner) surface. The hymenium (outer surface) is smooth and a buffy flesh color. Texture fleshy, but toughish and flexible.

Spores smooth, elliptic, 7.4-10 x 11-14.4μ. They are said to be straw-yellow but we did not get a heavy enough print to determine this point.

I have followed Burt in recognizing this species, but without conviction that it is distinct from the preceding.

1959. On a mossy bank by branch below Strowd's spring, November 3, 1915.

6. **Craterellus lutescenes** Pers.

This has not yet been found in Chapel Hill and the following is from Burt (Ann. Mo. Bot. Garden **1**: 336. 1914):

"Fructifications solitary to cespitose; pileus thin, somewhat membraneaceous, varying from convex and umbilicate to tubiform or funnel-shaped, often pervious, yellowish brown to fuscous, with margin often lobed or irregular; stem flexuous, cylindric, hollow, yellow, drying ochraceous buff, often hairy at the base; hymenium remotely ribbed, even or rugose-wrinkled, yellow, drying cadmium-yellow to ochraceous buff; spores even, 10-12 x 6-8μ.

"Fructifications 2½-5 cm. high; pileus 1½-3 cm. broad, stem 1½-4 cm. long, 2-4 mm. thick.

"On moist ground in woods and swamps. Newfoundland to North Carolina and westward to Michigan. August to October.

"This species probably ranks next to *C. cornucopioides* in frequency in the United States. The long and yellow stem readily distinguishes this species from *C. ochrosporous.* Specimens of *Cantharellus infundibuliformis* resemble those of *Craterellus lutescens* in form, size, and color, but those of the former species have true lamellæ."

Blowing Rock, Atkinson.
North Carolina. Schweinitz.
Low district, earth and woods. Curtis.

7. **Craterellus calyculus** (B. and C.) Burt.

Not yet found in Chapel Hill and known only from North Carolina and South Carolina. The following is from Burt (Ann. Mo. Bot. Garden **1**: 338. 1914):

"Fructifications somewhat fleshy-membranaceous; pileus thin, deeply cup-shaped, minutely tomentose, drying Saccardo's umber, opaque; stem apparently hollow, cream buff, attenuated below, tomentose at the base; hymenium even or slightly venose, cream buff; spores slightly yellowish under the microscope, even, 8 x 6μ.

"Fructifications 2-3 cm. high; pileus 4-8 mm. broad; stem 1 cm. long, 1-2 mm. thick.

"On ground in damp shady woods. North and South Carolina. August and September.

"Upon moistening, the type in Kew Herbarium proved too soft and fleshy and the hymenium too waxy for a *Stereum.* The sections have the structure of *Craterellus.* The species is near *C. sinuosus* and may prove to be a small form of this when ample material gives more complete knowledge of the species, but, for the present, I regard *C. calyculus* as a distinct species. I refer to *C. calyculus* a collection made by Professor Atkinson at Blowing Rock, North Carolina, the rough-dried and cespitose specimens of which show a somewhat tubiform pileus and spores. 7-8 x 4½μ."

Blowing Rock. Atkinson.
Low district, moist woods. Curtis.

CANTHARELLUS

Plants fleshy, growing on the ground or (in one case) on wood, stem central or laterally attached in one species, gills fold-like or somewhat thin and approaching those of a Hygrophorus with an obtuse edge, cap usually depressed in center, sometimes infundibuliform; spores buff or ochraceous or rosy pink or light salmon.*

Important literature:

Murrill, N. Am. Flora **9**: 167. 1910.
Peck, N. Y. State Cab. Rep. **23**: 121. 1872.
Peck, N. Y. State Mus. Bul. **2**: 34. 1887.

KEY TO THE SPECIES OF CANTHARELLUS

Stalk none or lateral, growing from the stems of living mosses.
  Plant with a lateral stalk; cap glabrous.........*C. muscigenus* (2)
  Plant sessile, cap finely downy.................*C. retirugus* (1)
Stalk central, not growing on mosses.
  Growing on rotting logs.......................*C. lignatilis* (12)
  Growing on ground.
    Cap pallid brown, gills ashy vinaceous........*C. infundibuliformis* (3)
    Cap grayish-drab, black when bruised, odor very musky ....*C. sinuosus* (4)
    Cap grayish-brown, gills white or creamy......*C. umbonatus* (11)
    Cap buffy-brown with lilac tint, flesh lilac.....*C. clavatus* (8)
    Entire plant cinnabar red or cap red and gills orange ....*C. cinnabarinus* (9)
    Cap some shade of yellow or orange.
      Cap deeply infundibuliform, stem hollow.
        Plants thin, small, less than 5 cm. broad..*C. infundibuliformis* (3)
        Plants larger, over 5 cm. broad............*C. floccosus* (5)
      Cap flat or only depressed, stem solid.
        Cap and gills orange.
          Gills distant ....*C. cinnabarinus, orange form* (9), *and C. minor* (10)
          Gills close ....*C. aurantiacus* (7)
        Cap and gills yellow or creamy........*C. cibarius* (6)

*Most authors speak of the spores as white for the genus, but this is not the case with our Chapel Hill plants. In all of our species so far collected the spores have been distinctly colored, when fresh. The color gradually fades in the herbarium. Beardslee writes me that the spores of Asheville plants show similar colors.

1. **Cantharellus retirugus** (Bull.) Fr.

Dictyolus retirugus in N. Am. Fl. **9** : 166.

PLATES 7 AND 16.

Cap up to 1 cm. broad (said to reach 2 cm.) quite sessile by the dorsal surface, often hanging from center, but usually eccentric or almost laterally seated at times, bell or shell-shaped when young, then more expanded to saucer-shaped or broadly petalloid; very thin and delicate, nearly pure white and finely downy when young, so that the incurved margin is delicately fimbriate, at maturity the down collapses and the surface fibers split and separate like the surface of a cocoon.

Gills very rudimentary, composed of irregular folds or veins in center which may branch and deliquesce quite irregularly, fading away before the margin is reached, or the surface may seem merely pitted (as in Auricularia) rather than veined, and often is almost smooth; when young the hymenium is nearly white, then pale ashy straw, the upper surface making the same change or remaining more whitish.

Spores (of No. 3224) pure white, smooth, subelliptic to pip-shaped, 4-4.5 x 6.6-8.5μ.

The place of attachment is usually a mm. or more wide, the surface fibers disappearing into the moss. So exceedingly delicate is the plant that it dries up to an earth gray or darker crumpled particle so inconspicuous as to be found with difficulty even on preserved material where it is known to be plentiful. It breaks easily from the moss when dry and revives very little when moistened.

This is certainly *C. retirugus* and not *C. muscigenus*. Bulliard's figure (Pl. 498, fig. 1) represent our plants exactly. It has not been reported heretofore south of our most northern states and ranges northward to Alaska and Greenland. Schweinitz reports *C. muscigenus* from North Carolina, but not this species. We have not found the former.

3224. Parasitic on a moss, bank by road east of campus. Jan. 27, 1919. Photo. Plentiful.

PLATE 7

CANTHARELLUS RETIRUGUS. No. 3224

2. **Cantharellus muscigenus** Fr.

We have not found this plant and take the description from Murrill (N. Am. Flora **9**: 165. 1910, as Dictyolus). It is easily distinguished from *C. retirugus* by the lateral stalk, darker color, glabrous cap and less delicate substance. For good illustrations see Bulliard, Pl. 498, fig. 2, and Cook, Illustrations of British Fungi Pl. 1115 (1065).

"Pileus submembranaceous, laterally stipitate, spatulate, 1-2.5 cm. broad; surface glabrous, zonate, fuscous to whitish cinereous; margin entire to undulate or lobed; lamellæ distant, dichotomous, concolorous; spores ellipsoid, smooth, hyaline, 10-12 x 6-9μ; stipe short, concolorous or slightly darker, villose at the base."

Middle district on mosses. Schweinitz.

3. **Cantharellus infundibuliformis** (Scop.) Fr.

Gregarious or cespitose. Cap. 2-3.3 cm. broad, irregular, deeply depressed in center and at times with a hole in the center leading down into the hollow stem; margin undulate, broadly drooping or almost plane; surface peculiar, roughened by pits, channels and ridges, the latter terminating in small, pointed squamules which are much more numerous towards the margin; color varying from a reddish ochraceous orange, near capucine orange, to a pallid brown. Flesh toughish, fleshy, tinted like the cap, only 1-1.5 mm. thick, almost tasteless and quite odorless.

Gills distant, connected by large, irregular veins, a few forking, the wider ones about 2.5 mm. broad, with narrower ones between, the edges fairly sharp for a cantharellus, especially in fully mature plants; color varying from a dull salmon, exactly salmon-buff of Ridgway at maturity, to ashy vinaceous.

Stem 2-4.5 cm. long, 3-4 mm. thick in center, smooth, clear orange color, much more brightly colored than the other parts usually, straight or crooked and irregularly, flattened, pinched or channeled, quite hollow from top to bottom, the cap pierced and opening into this hollow in only two of our collections, often so in others.

Spores buffy-salmon, elliptic, smooth, 5.5-8.5 x 8-11.8μ.

A very variable plant, particularly in color of cap and gills, but easily recognized by the clear orange color of the cavernous stem. Bresadola figures a branched or densely cespitose form that he calls var. *subramosus* (Fungi Trident. **1**: 87, Pl. 97). The colors shown are not accurate for our plant.

1549. Woods south of athletic field, June 18, 1915.
2200. Sandy soil in low places in woods near Mr. Pritchard's, June 20, 1916. Photo.
2325. Edge of path along northern Meeting of the Waters branch, mixed woods, June 30, 1916.
2353. Pine woods south of cemetery, July 3, 1916.
2681. Low damp woods, Battle's Park, July 13, 1917. Cap perforated into the stem.
2706. Damp woods near Battle's Branch, July 17, 1917. Cap perforated into the stem.
2757. In humus, upland woods, Battle's Park, July 22, 1917.
3263. Under oaks, Battle's Park, May 30, 1919. Painting.
3346. Low woods in front of cemetery, June 12, 1919.

Blowing Rock. Atkinson.
Middle district (Schw.) woods among leaves. Curtis.
Asheville. Beardslee.

4. **Cantharellus sinuosus** Fr.

PLATES NO. 9 AND 16.

Plants about 3-7 cm. high, rather abruptly expanded above and strongly crenated and lobed, the margin elevated or drooping; surface lightly ridged and grooved, somewhat felted and slightly squamulose, especially near the margin, the center passing down gradually into the hollow stem, or at times with more of the appearance of having been perforated into the stem; color grayish-drab, blackening in age or when bruised. Flesh toughish, elastic, only 1-2 mm. thick, color of cap, odor a very decided musky fragrance, taste not distinct.

Hymenium composed of vein-like wrinkles, which are more elevated radially, with lower and irregular anastomosing ones, all blunt and not more than 1 mm. high, color like that of cap with a tint of flesh added, moderately decurrent.

PLATE 8

CANTHARELLUS INFUNDIBULIFORMIS. No. 2200.

PLATE 9

CANTHARELLUS SINUOSUS, No. 2284

Stem 2-4 cm. long, irregular, more or less ridged and longitudinally rugose, color of cap but usually lighter, hollow except at the base.

Spores white apparently (spore print too light to be sure), elliptic, smooth, some bent, 3.7-5 x 6.6-9.6μ.

From the strong odor of this plant I refer it to *Cantharellus sinuosus* Fr., but the spores are more like those of *C. cinereus* Fr., as described, which is not decidedly odorous. It is easily distinguished from *C. infundibuliformis* by the odor, color, and much smaller spores.

2284. Base of a rotting deciduous stump near Dr. Pratt's, June 28, 1916. Photo.

2675. At foot of white oak by Battle's Branch, July 14, 1917. Odor strongly aromatic.

5. **Cantharellus floccosus** Schw.

PLATES 10, 11 AND 16.

Plants gregarious, sometimes cespitose. Width up to 13.5 cm. or more and height the same, very deeply infundibuliform, the depression running way down the stem, the margin erect, except at complete maturity when it is spread out and may be beautifully fluted. Color of surface orange, very deep or light orange when old, covered with a flocculence which becomes soft and agglutinated when wet. Flesh of all parts white except just under the surface, thin, only about 5 mm. thick, somewhat acid in taste, no smell.

Gill surface running way down the stem, the low broad ridges so much anastomosed as to have no individuality for any distance except on stem. Color creamy with light tints of pinkish or orange brown, the marginal parts lighter.

Stem usually bent below, tapering downward and pointed at base and continuous with and not distinct from cap; hollow to near the base.

When young the plant is shaped like a long hollow club, growth later taking place above and forming the spreading top.

Spores (of No. 1588) ochraceous yellow, elliptic, smooth, 7-8 x 12-15μ.

Illustrations: Peck. Edible Fungi, Pl. 55, figs. 9-13, also Report N. Y. St. Mu. **52**: pl. 60, figs. 10-14.

Montreat. Rich humus under Rhododendron and Hemlock by branch, July 6, 1915. (No. 1588.) Photos. W. C. Coker.
Blowing Rock. Atkinson.
Middle and upper districts. Curtis.

6. **Cantharellus cibarius.** Fr.

PLATES 1, 12 AND 16.

Cap usually from 2.5-6 cm. broad, rounded when young, depressed or flat when old, the margin nearly even or wavy, bent down when young, plane or elevated when mature. Surface smooth or minutely roughened, deep chrome-yellow, or paler yellow. Flesh yellow under the surface, nearly white elsewhere, firm and toughish, odor of apricots in our plants. Taste pleasant, usually slightly peppery.

Gills low but rather thin, about 1 mm. deep, branching about twice, decurrent, anastomosing somewhat but not conspicuously, chrome yellow or lighter.

Stem about 3-4 cm. long to the gills, usually bent, nearly equal, smooth, pale yellowish or cream color, tough, firm and solid.

Spores (of No. 1599) a clear orange-yellow, exactly color of the gills in a heavy print (but see No. 1168, below) elliptic, smooth, 4-5.5 x 7-8μ.

Distinguished from *Craterellus cantharellus* by the distinct salmon-pink spores, the more orange color of cap and gills, and by the lower, more vein like and often absent gills of that species.

Illustrations: Gibson. Our Edible Toadstools and Mushrooms, pl. 19; Taylor. Food Products III, p. 4; Peck, N. Y. St. Mu. Bull. **150**: pl. 122, figs. 8-16.

195. Battle's Park, near Dr. Battle's house, September 14, 1910.
699. Damp, cool spots along Battle's branch, June 20, 1913.
1168. In hollow below sphagnum moss bed and by old road southeast of athletic field, July 20, 1914. Photo. Spores salmon pink, exactly as in *Craterellus cantharellus*, elliptic granular, some with an oil drop, 3.7-4.6x7.4-9.2μ. Except for the spore color these plants are exactly *Cantharellus cibarius*.
1547. In pine woods, near path to Judge's Spring, June 18, 1915.
Spores light buff (Ridgway), elliptic, smooth, 4.5-5.5 x 7.2-9μ.

PLATE 10

CANTHARELLUS FLOCCOSUS, No. 1588

PLATE 11

CANTHARELLUS FLOCCOSUS. Reduced 1/6. No. 1588

1557. By path near branch west of Meeting of the Waters, June 19, 1915. Spores light buff, 4.5-5.4 x 7.2-9.5μ.
1564. In several spots along Battle's branch, June 20, 1915. Photo.
1599. In woods near branch, west of the Meeting of the Waters, July 13, 1915. Photo.
1610. On bank above Howell's Branch, July 15, 1915.
2321. Oak grove at Gimghoul Lodge, June 30, 1916. Montreat, July 6, 1915. No. 1590. Coker. Spores elliptic, smooth, light buff, 4.5-5.4 x 6.8-8μ.
2728. Mixed upland woods, Battle's Park, July 20, 1917. Cap 9.6 cm. broad.
3292. Battle's Grove and Park, June 2, 1919. Painting.

Blowing Rock. Atkinson.
Common in Woods. Curtis.
Asheville. Beardslee.

7. **Cantharellus aurantiacus** Fr.

We have not found this species in Chapel Hill, and the description below has been kindly furnished by Mr. H. C. Beardslee. The species is very different from others of the genus, the thin, broad gills forking like those of an Agaric. It is also easily distinguished from *C. cibarius* and *C. cinnabarinus* by the white instead of salmon-colored spores. In the state Herbarium at Albany, N. Y., there are specimens up to 12 cm. broad.

"Cap rounded hemispherical, becoming expanded and plane or depressed, 3-7 cm. broad, somewhat tomentose, dull orange. Flesh thin at the margin, which is at first incurved and irregular. Gills thin, crowded, forking, decurrent, and bright orange. Stem 2-6 cm. long, 4-8 mm. thick, colored like the cap, but darker at the base, nearly smooth above, tomentose below. Spores white, 4-5 x 6-8μ.

"In woods, growing on and around well decayed logs.

"This species is very distinct from *C. cibarius*. The bright orange gills which are much broader and thinner than in *C. cibarius* at once distinguishing it. At Asheville it is not common, but is found every summer."

Illustrations: Cook. loc. cit. Pl. 1104 (1057); Atkinson. Mushrooms, figs. 127 and 128. Gillet. Champ. de Fr. Pl. 86 (141); Richon et Roze. Atlas Champ. Pl. 49, figs. 16-19. Michael, Fürhrer f. Pilzfreunde 1: Pl. 29.

Middle District. Schweinitz.
Blowing Rock. Atkinson.
Asheville. Beardslee.

8. **Cantharellus clavatus** Pers.
Cantharellus brevipes Pk.

PLATES 13, 14 AND 16.

Plants clustered and some with fused stems, up to 16 cm. broad and 16 cm. high, deeply infundibuliform or with only slightly elevated margins and undulately plain; the margins sometimes bent down, sometimes straight; surface nearly smooth, slightly pruinose, the very thin superficial layer easily splitting into fibers so that the surface becomes marked with lines and areas where the lighter colored layer shows; color buffy-brown, distinctly tinted with lilac, which is the result of the *deep lilac flesh* showing through. The color varies in different parts of the cap, the margin as it dries showing little lilac. As the plant gets old a rosy tint is added to the lilac flesh and also to the cap, and this may grow deeper until both become rosy red with a tint of lilac. The rosy color of the cap becomes darker and sordid as decay begins. Flesh of the cap soft and spongy, but not fragile; taste very mild and pleasant.

Gills rounded, vein-like, composed of ridges and folds that are approximately parallel towards the margin, anastomosing more downwards and strongly decurrent. The color of the gills and surface between is a deep lavender brown, much deeper than the cap, and with the maturity of the spores their cinnamon color is added to the other tints as an obviously superficial dusting.

Stem about 6-8 cm. long, tapering downward, solid, much more firm than the cap, nearly smooth and colored like the hymenium except at the base which is white; the flesh like that of the cap, a deep lavender, turning through gray to white at base. The plants are often fused at base and several caps may arise from one stem. The stem is usually central, but may be lateral through the failure of the caps to expand on one side. When placed on white paper when fresh the gills leave a permanent light lavender stain.

Spores cinnamon-buff, long-elliptic, smooth, 3.7-4.6 x 12-15.7μ.

This interesting and very rare plant is new to the South, and has been collected only a few times even in the North. Murrill in N. Am. Flora **9**: 171. 1910, lists it as doubtful, saying "It does not

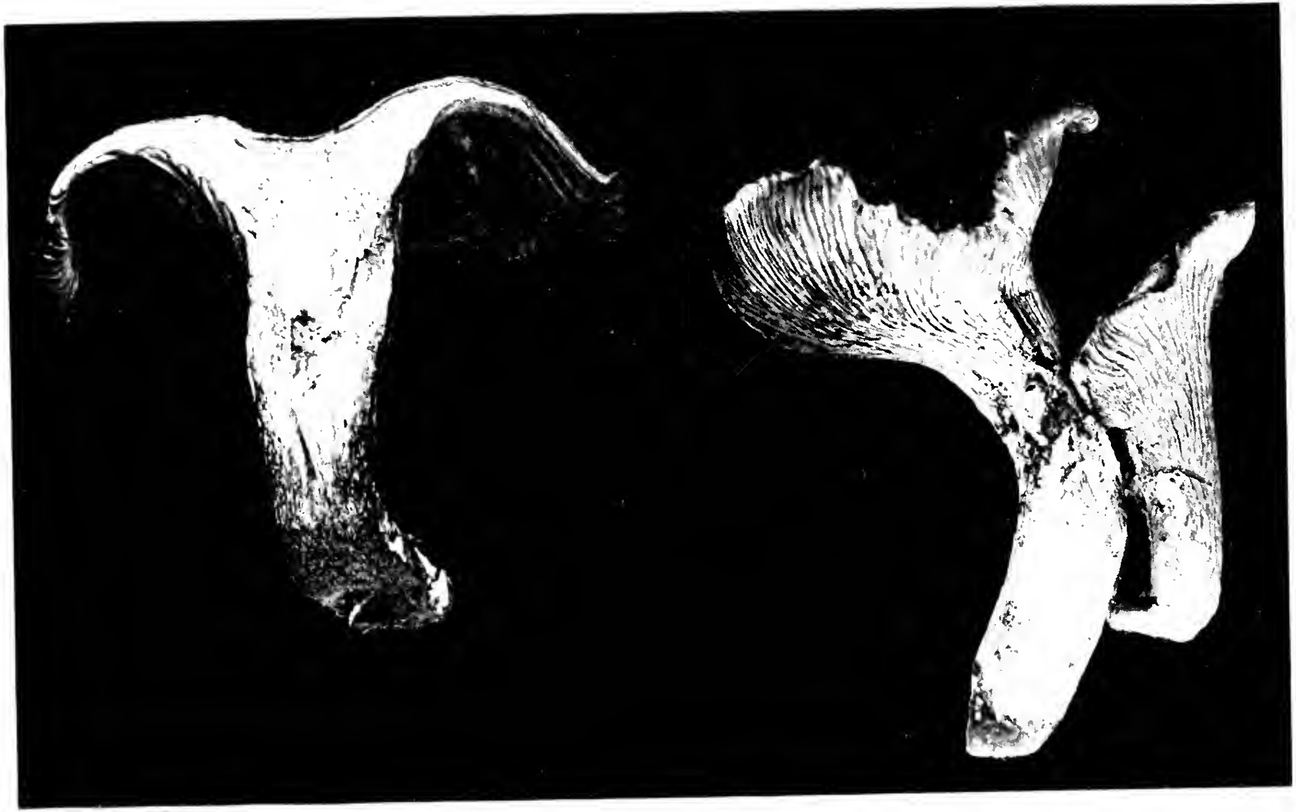
PLATE 12

CANTHARELLUS CIBARIUS. No. 2321a

PLATE 13

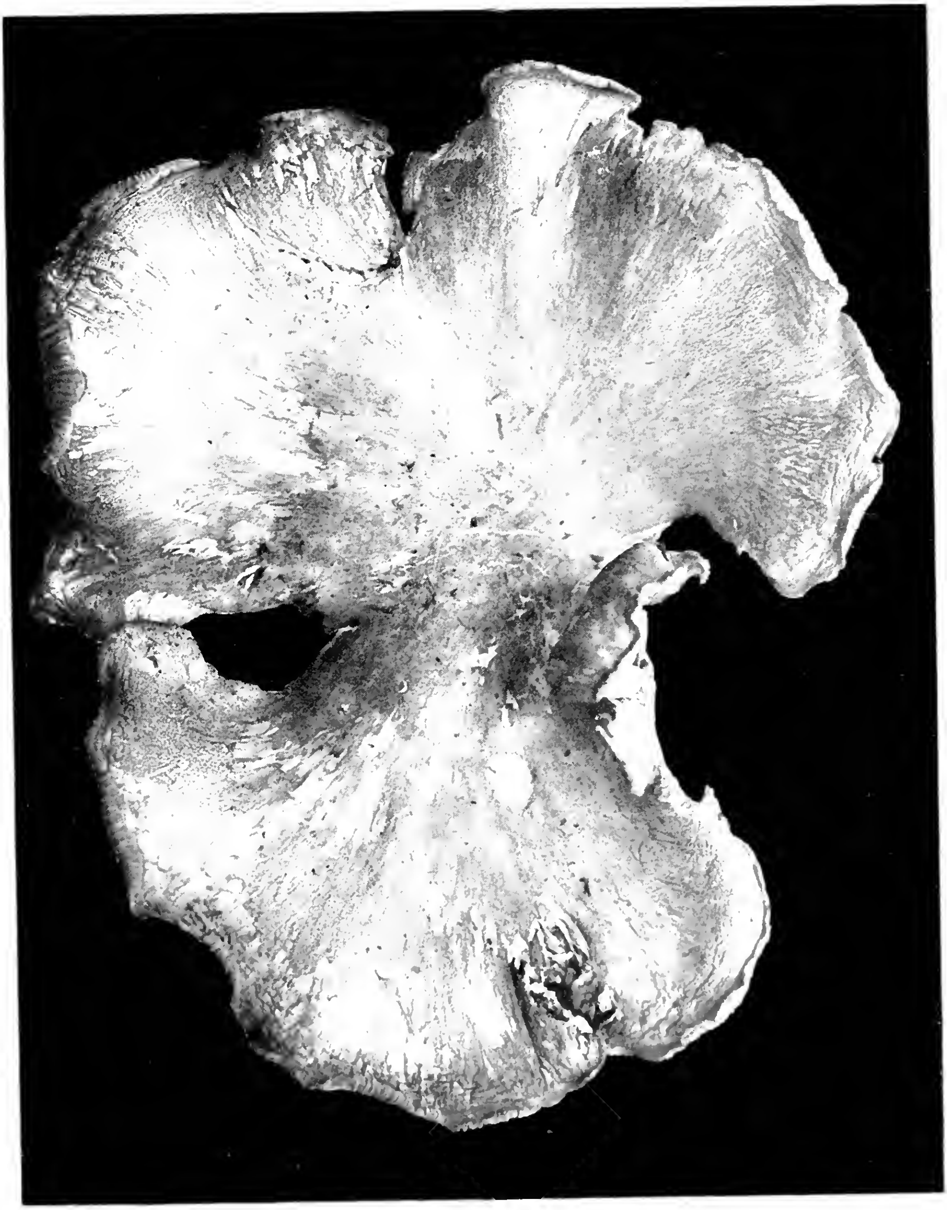
CANTHARELLUS AURANTIACUS *(Photo by Beardslee)*

PLATE 14



CANTHARELLUS CLAVATUS. Reduced $1/5.3$. No. 918

PLATE 15



CANTHARELLUS CLAVATUS, Reduced 1/6.5. No. 918

appear to be sufficiently distinct from *C. floccosus*." It is, however, very different from the latter and is quite distinct. (See Mycologia **5**: 261. 1913.)

The species is placed under Craterellus by Burt (Ann. Mo. Bot. Gard. **1**: 329. 1914). There is good authority either way, and the two genera are very closely connected.

Illustrations: Bresadola. Funghi. Mangr. Pl. 82. (as Cantharellus); Krombholz. Abbild. u. Beschr. Pl. 45. figs. 13-17 (as Cantharellus.)

918. On ground in deciduous woods on hillside, north side of Rocky Ridge Farm. Oct. 16, 1913. Three Photos.
927. In mixed open woods near Judge's Spring, Oct. 18, 1913.

9. **Cantharellus cinnabarinus** Schw.

PLATES 1, 15 AND 16.

Cap. 1.5-4 cm. broad, umbilicate and the margin inrolled when young, then funnel shaped from the elevation of the margin, often crenated or strongly lobed, surface soft, fibrous, smooth or more often roughish or subtomentose or minutely squamulose, dry, dull; color a strong and characteristic cinnabar-red all over, typically, but varying to a clear strong orange all over and with all intermediate shades. Flesh thin, toughish, color of the cap or lighter; taste mild or slightly to distinctly peppery; odor aromatic, like that of *C. cibarius*.

Gills distant, strongly decurrent, about 1-2 mm. wide, connected by thick, low veins, about color of cap or sometimes orange when the cap is cinnabar.

Stem slender, toughish, firm, solid, about 2-2.5 cm. long and 2-3.5 mm. thick, smooth or roughish, about color of cap.

Spores a pretty rosy pink when fresh in cinnabar plants, but varying to pale orange in orange plants, fading after a time in the herbarium, elliptic, smooth, about 4-6 x 6-9μ.

This is an attractive and easily recognized little species that is usually found on mossy soil near branches or in low places in woods. It is very common with us and is excellent as an edible. The orange form may contrast strongly with the cinnabar plants and are confusing to beginners. The color is, however, the only difference, and one often meets with cinnabar plants with contrasting

orange gills and there are all color shades between deep cinnabar and strong orange. Old plants may become very pale and blotched with dull white. The spores partake of the color of the gills. Odor, taste, size, shape, surface and spores are all identical in the different color forms.

Peck has described a small orange plant, 1-2.5 cm. broad, as *C. minor*, and Atkinson has found it at Blowing Rock. In Chapel Hill many plants of *C. cinnabarinus* are as small as this and I can detect little if any other difference of consequence from the description. However, not knowing these to be the same, I include *C. minor* with the strong suspicion that it is not distinct.

196. Battle's Park, near Dr. Battle's house, mixed woods, Sept. 14, 1910. Spores 4-6 x 6-9μ.
371. Battle's Park, by branch, Oct. 18, 1911.
546. Battle's Park, near branch, Oct. 10, 1912. Photo.
1189. By branch southeast of Graded School, July 22, 1914.
1251. By Battle's branch, at Lover's Leap, Sept. 23, 1914.
1548. Low woods near Meeting of the Waters, June 18, 1915. Orange form. Spores exactly as in red form, except for color which was *orange pink*. 3.6-5.4 x 7.2-10μ.
1556. Damp soil in hollow below Sphagum bed, July 19, 1915. Spores elliptic, smooth, 4.6-5.4 x 7.2-10μ.
1565. By old Raleigh Road, under pines northeast of Judge Brockwell's, June 20, 1915. Spores rosy pink.
1634. Damp soil by Meeting of the Waters branch, July 23, 1915. Spores a pretty rosy-pink color when fresh, elliptic, smooth, 3-5.4 x 6.8-8μ.
2341. Woods, Chapel Hill, July 2, 1916. Photo.
3265. Low place in deciduous woods, Battle's Park, May 30, 1919. Painting.
3360. By Battle's branch, June 24, 1919. Spores light orange color, 4-5.1 x 7.4-9.3μ. Painting.

Asheville. Beardslee.
Common in damp woods (as Hygrophorus). Curtis.

10. **Cantharellus minor** Pk.

This plant is probably only a form of *C. cinnabarinus*, as mentioned above.

The following is from Murrill (N. Am. Flora **9**: 169, 1910):

"Pileus thin, fleshy, convex to expanded, irregular or depressed at times, gregarious, 1-2.5 cm. broad; surface glabrous, subrugose, ochraceous to orange; margin inrolled at first, entire or repand: con-

PLATE 16

CANTHARELLUS CINNABARINUS. No. 546

text thin, pallid, mild, at length faintly peppery; lamellæ decurrent, distant, very narrow, often forking, seldom anastomosing, concolorous: spores ovoid, somewhat one-sided, smooth, hyaline with a faint yellowish tinge, 8-9 x 4-5μ: stipe slender, cylindric, equal, glabrous, shining, slightly striate at times, concolorous, usually solid, 2-5 cm. long, 2-4 mm. thick."

Blowing Rock. Atkinson.

11. **Cantharellus umbonatus** Fr.

The following is from Murrill (N. Am. Flora **9**: 170. 1910):

"Pileus obconic, usually umbonate, convex to expanded, often depressed, fleshy, flexible, gregarious, 1.5-4 cm. broad; surface flocculose to glabrous, usually smooth, dry, varying from light to dark grayish-brown, margin regular, involute, concolorous; context white, thin, mild, edible; gills decurrent, white or yellowish-white, becoming reddish when wounded, close, regular, more or less dichotomous: spores narrowly ellipsoid, smooth, hyaline, 8-10 x 4μ: stipe 3-8 cm. long 4-8 mm. thick, equal or tapering upward, subglabrous, solid, whitish tomentose at the base, white or colored like the pileus above."

I find this note by Curtis in the Berkeley-Curtis Manuscript:

2837. "(Canth. umbonat., Fr.) Cap 1-1½ in. broad, acutely umbonate and depressed, pale fuliginous and scaly, margin thin involute, exceeding the gills. Lam. whitish, subcrowded, narrow, ascending from the stipe, subarcuate, all 3-5 forked. Stipe subequal, 1-2 in. long, 2 lines thick, rather paler than the cap, solid, appressed, fibrillose, base white mycelose. Spores white! Among leaves in dry woods. Nov."

Illustration: Cook. loc. cit., Pl. 1106 (1058).

Common, woods among leaves. Curtis.

12. **Cantharellus lignatilis** B. and C.

This species does not seem to have been found since its first collection by Ravenel, and our knowledge of it is quite meager. It may not be a Cantharellus.

The original description is as follows (Ann. Mag. N. H. **44**: 294. 1859):

"Reddish-brown; pileus 2 in. across, smooth, infundibuliform, deeply striate, stem 2 in. or more high, 1/4–1/3 in. thick, smooth;

folds thin, decurrent. Of this we have no notes, but the peculiar habit and characters will distinguish it. Curt. No. 1979. On rotten logs, S. C., H. W. Ravenel."

Low district, on carious wood. Curtis.

PLICATURELLA

Plants laterally attached, sessile or with a short stalk, subfleshy; gills fold-like; spores rust color; no veil. This genus differs from Cantharellus in the lateral attachment and rusty spores.

There is but one species.

Plicaturella olivacea (Schw.) Murrill

Cantharellus olivaceus Schw.

The following is from Murrill (N. Am. Flora **9**: 172. 1910):

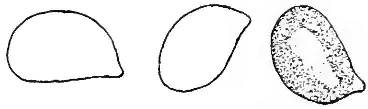
"Pileus subfleshy, dimidiate, subimbricate, slightly depressed, 2.5-4 cm. broad, 3-4 mm. thick, sessile or attached by a short thick stipe which is black and strigose; surface yellowish-green, pulverulent or finely pubescent, margin subinflexed, undulate or lobed: context homogenous, olivaceous, fragile when dry, 2.5-3 mm. thick; lamellæ anastomosing, dichotomous or branched, crowded, rather broad, orange-yellow to reddish-brown; spores ovoid, smooth, ferruginous, 5 x 4μ."

Salem. Schweinitz. Type locality.

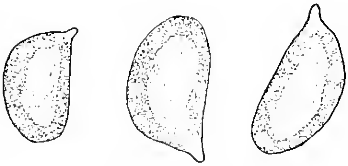
CHAPEL HILL, N. C.

PLATE 17

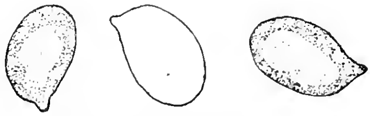
Nyctalis asterophora, No. 1789



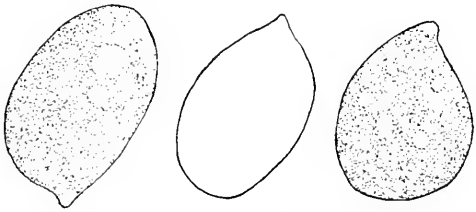
Craterellus cantharellus, No. 1157



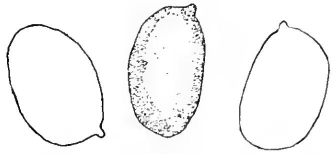
Craterellus odoratus, No. 2642



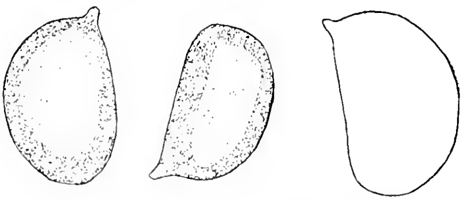
Cantharellus retirugus, No. 3224



Craterellus cornucopoides, No. 2195

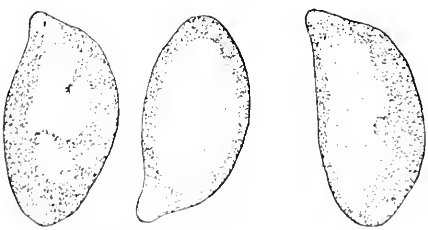


Cantharellus sinuosus, No. 2284

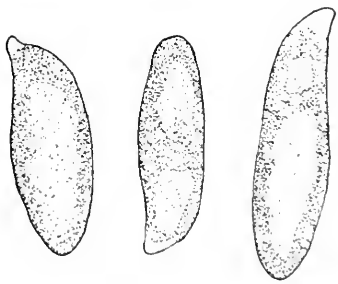


Cantharellus infundibuliformis, No. 2200

Cantharellus cibarius, No. 2319

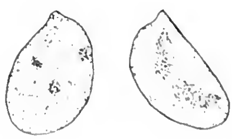


Cantharellus floccosus, No. 1588



Cantharellus clavatus, No. 918

Cantharellus cinnabarinus, orange form, No. 1548



Cantharellus cinnabarinus, No. 1556

No. 1789 x 670. All others x 2160

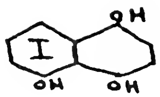
JUGLONE

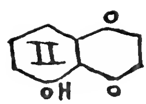
By Alvin S. Wheeler

The American supply of dyes was very suddenly cut off when the Great War began in 1914, and the ports of Germany were blockaded. We were forced to turn to natural dyestuffs and to increase our production of synthetic dyes. The progress in American manufacture has been so great that the production of dyes in the United States in 1917 was nearly equal in total weight to the annual importations before the war.

NATURAL DYESTUFFS

The natural coloring matters are very numerous but they are not always fast and their quality is not apt to be uniform. The most important plants which are used as a source of commercial dyestuffs are indigo, logwood, madder, cutch, fustic, turmeric, archil, sandal wood and quercitron bark. There are, however, many other sources of dyes and among these is the walnut hull, long used on the small scale by the thrifty housewife. The coloring matter has great tinctorial power as any one knows who has removed the hulls from walnuts. When these hulls are used and this is still done at the present day, the dye imparted to the goods is a beautiful brown and is very fast. I am told that the dye is also obtainable from the leaves, bark and roots of the walnut tree. The walnut hull contains an aromatic compound called $^{\alpha}$hydrojuglone which is a phenol in the naphthalene series with hydroxyl groups at positions 1, 4 and 5. Its formula therefore is (I).





It is with great difficulty soluble in water, forming a one-half per cent solution at 25° C. It is readily soluble in alkaline liquids, forming intense yellow solutions. This is most likely the dye which has been used so much, especially by the farmer's wife. This hydro-

juglone is very readily oxidized, even by iron chloride, to juglone, the subject of this paper. The oxidation affects the hydroxyl groups at positions 1 and 4, removes the hydrogen atoms and thus produces a quinone (II). Juglone is therefore 5-hydroxy-1-4-naphthoquinone.

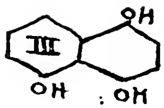
HISTORY OF JUGLONE.

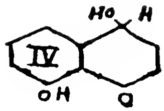
Juglone was first mentioned by Vogel and Reischauer[1], who obtained it from fresh walnut hulls. It is next referred to by Phipson[2] who called it regianin. His product was evidently not pure. In 1877 Griessmayer[3] published Reischauer's notes on juglone (the first appearance of this name) giving an analysis of this compound and its copper salt. The names given above are derived from the botanical name of the walnut tree, Juglans regia. Bernthsen[4] gave a number of reasons for believing it to be an hydroxynaphthoquinone. Bernthsen and Semper[5] extracted 150 kilograms of ripe walnut hulls with ether and obtained a yield of 150 grams or 0.1% of pure juglone. By the action of nitric acid they obtained juglonic acid or dinitrohydroxyphthalic acid, showing that the hydroxyl group in juglone is in the benzene ring. Mylius[6] fused juglone with potash and obtained m-hydroxybenzoic acid and salicylic acid. Bernthsen and Semper[7] prepared the dioxime, having made the monoxime earlier. These reactions established the constitution of juglone as being 5-hydroxy-1, 4-naphthoquinone. Finally Bernthsen and Semper[8] synthesized juglone by oxidizing 1, 5-dihydroxynaphthalene with chromic acid, obtaining a yield of 30-40 per cent, a record which I have never been able to make. I have varied the process in many ways and never get more than 16 per cent. The acetyl derivative and the monoxime of the synthesized juglone were found to be identical with those obtained from the natural juglone.

1Buchner Neues Repert. für Pharm. **5**: 106. 1856; L' Institut 1857, 71.
2Compt. rendus., **69**: 1372. 1869.
3Ber.desdeutsch.Chem.Ges., **10**: 1542. 1877.
4Ber.d.d.Chem.Ges. **17**: 1945. 1884.
5Ber.d.d.Chem.Ges., **18**: 203. 1885.
6Ber.d.d.Chem.Ges., **18**: 463. 1885.
7Ber.d.d.Chem.Ges., **19**: 164. 1886.
8Ber.d.d.Chem.Ges., **20**: 934. 1887.

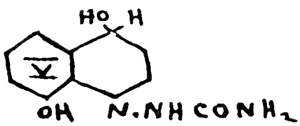
THE HYDROJUGLONES

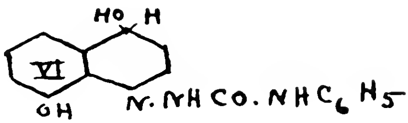
Not only juglone but also α-hydrojuglone and its isomer, β-hydrojuglone, have been the subjects of considerable study in the Organic Laboratory of the University of North Carolina. The first important discovery was the demonstration that the two hydro-juglones were isomeric keto and enol forms, their formulas being III and IV:





This investigation was begun in the chemical laboratory of the Swiss Federal Polytechnic at Zurich and was completed in Chapel Hill. The report is found in the Berichte d.d.Chem.Ges., 47, 2796 (1914). That the alpha compound contains three hydroxyl groups is shown by its conversion into a triacetyl derivative with acetic anhydride. That there is no ketone group present is shown by our failure to obtain an oxime or a semi-carbazone. The beta-compound also forms a triacetyl derivative but this is because the acetic anhydride has an enolizing action, causing the hydrogen in position 1 to move to position 4, thus reforming the alpha-compound. However, ketone reagents such as semicarbazine and phenylsemicarbazine readily convert the beta-compound into semicarbazones, V and VI:





These two reagents are successful because of their weak basic properties. The hydrojuglones are very sensitive to alkalies, so that the usual ketone reagent, hydroxylamine, decomposes them instead of giving an oxime. Semicarbazine is less basic on account of the presence of the carbonyl group and phenylsemicarbazine is still less basic since it contains in addition the phenyl group. This gives a strong hint that phenylsemicarbazine should be a delicate reagent for those keto-phenols which are particularly sensitive to alkalies.

HALOGENATION OF HYDROXYNAPHTHOQUINONES.

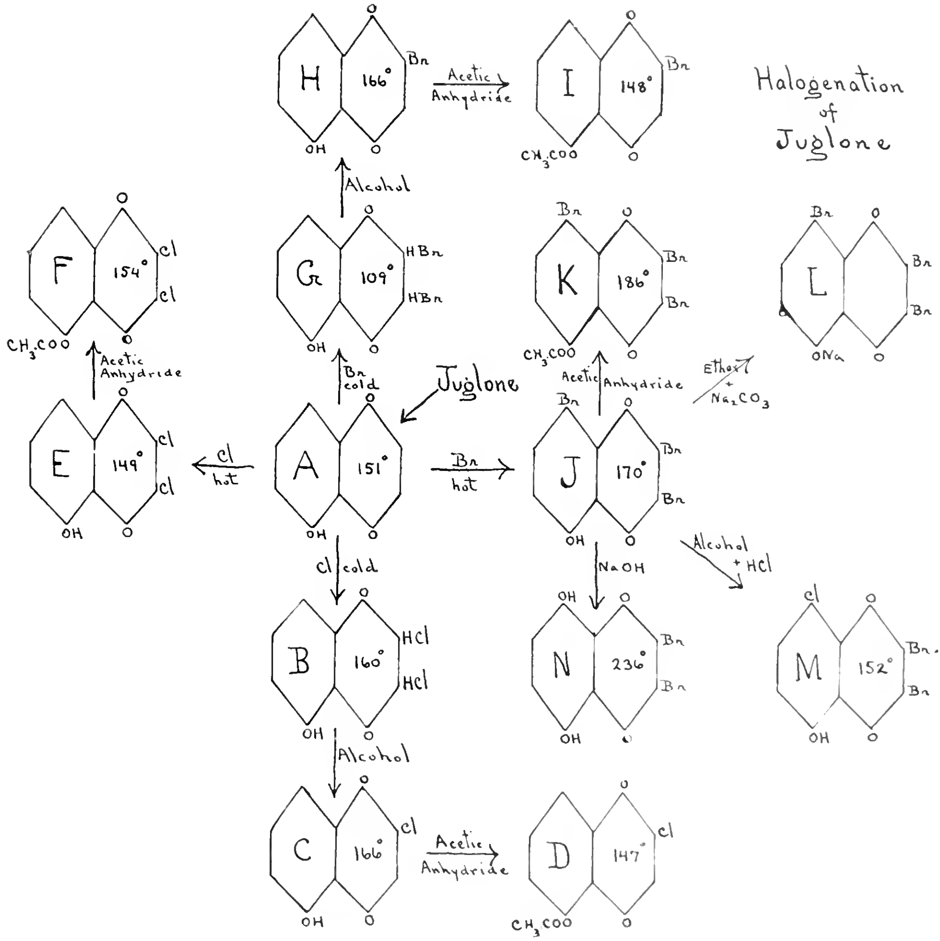
The next investigation undertaken here was the behavior of juglone with the halogens, chlorine and bromine. This work was done with the assistance of J. W. Scott, candidate for the degree of Doctor of Philosophy. Very little work indeed has been published on the behavior of naphthoquinones with halogens. Diehl and Merz[9] discovered 3-bromo-2-hydroxy-naphthoquinone. Kehrmann and Mascioni[10] prepared the analogous iodo compound. Zincke and Schmidt[11] made naphthazarine dichloride and 2-chloronaphthazarine. That is a very short story. In 1917 I published with V. C. Edwards[12] our study of the bromination of naphthazarine and of 1,4,5,6-tetrahydroxynaphthalene, reporting eight new derivatives of the first compound and nine of the second. If we add to this the new work on the halogenation of juglone, we see that this very small field has been very greatly extended, and the end is not yet.

HALOGENATION OF JUGLONE.

The accompanying chart (pl. 18) shows clearly in outline the work on the halogenation of juglone. Chlorine and bromine were used, the juglone being dissolved in all cases in glacial acetic acid. The action of the halogens is very different in a hot acid solution from that in a cold solution. If the halogen is added to a cold solution, the addition products, B and G, are obtained. These are called juglone dichloride and juglone dibromide. Each of these loses one molecule of halogen acid by the action of warm alcohol, yielding the monohalogen substitution products, C and H. The proof that these still contain the hydroxyl group is shown by the ready formation by acetic anhydride of the acetyl derivatives, D and I. If, however, the halogens are added to hot solutions of juglone, then substitution products are obtained which are far more stable than the addition compounds. We find here, however, a difference in the action of the halogens for, strange to say, juglone takes up only two chlorine atoms, E, as against three bromine atoms, J. These compounds behave in the same way

[9] Ber.d.d.Chem.Ges., **11**: 1066. 1878.
[10] Ber.d.d.Chem.Ges., **28**: 345. 1895.
[11] Annalen der Chemie, **286**: 41. 1895.
[12] Jr.Amer.Chem.Soc., **39**: 2460. 1917.

PLATE 18


Halogenation
of
Juglone
Juglone
A
151°
B
160°
C
166°
D
147°
E
149°
F
154°
G
109°
H
166°
I
148°
J
170°
K
186°
L
M
152°
N
236°
Cl
hot
Cl cold
Br
hot
Br
cold
Alcohol
Acetic
Anhydride
NaOH
Alcohol
+ HCl
Ether
+
Na_2CO_3
HBr
HCl
CH_3COO
OH
ONa

with acetic anhydride, giving the acetyl derivatives, F and K. Much more attention has been paid to tribromojuglone than to dichlorojuglone. Tribromojuglone, on being heated with an alcoholic solution of hydrochloric acid loses one bromine atom which is replaced by a chlorine atom, M. Again, on being heated with an alcoholic solution of caustic soda, one bromine atom is replaced by the hydroxyl group, N. These two reactions indicate that one bromine atom is unlike the other two, that is, its environment must be different. This fact is expressed in the formula given, in which one bromine atom is placed in position 8. This gives a unique position to one bromine atom, placing it in the phenol ring where it ought to be more reactive. On the other hand, the other two bromine atoms being alike are therefore placed symmetrically in the quinone ring. Finally tribromojuglone forms a sodium salt, L.

NEW DYES.

Dichlorojuglone consists of golden brown needles and tribromojuglone of brilliant rich red needles. Being highly colored and containing at the same time a reactive hydroxyl group these compounds should be typical dyes, and my experiments have shown that they are in reality very beautiful dyes. So far more attention has been paid to tribromojuglone. If this compound is dissolved in ether and the solution is shaken with an aqueous solution of sodium carbonate, an indigo blue salt separates out. This readily dissolves in water. If a piece of silk or wool is placed in the solution and the solution is boiled, the purple color of the solution quickly changes to a yellow, showing a reaction between the textile and the sodium salt. Silk is thus dyed a very beautiful champagne and wool a medium shade of tan. No mordant is necessary to fasten the color on the goods. However, if mordants are used the shades are changed in a number of instances, especially with wool. In only one instance was a change noticed with silk, a tin mordant producing a greenish bronze tint. Cotton is not affected by the dye unless it is mordanted. If the cotton is first impregnated with tannic acid, and then with the dye, it assumes an ecru color.

The dichlorojuglone is also a dye and imparts to silk a rich reddish bronze color. Other compounds such as C, H, M and N are un-

doubtedly dyes, but their dyeing properties have not yet been studied. No dyes so far described in the literature or patented belong to this series of naphthalene compounds, hence they constitute a new group. An application for letters patent has been made to cover this new class and the patent will undoubtedly soon be allowed.

THE NEW HALOGEN JUGLONES.

A brief description of these new halogen derivatives of juglone follows. Juglone dichloride,B, lemon yellow plates, recrystallized from ligroin, melts at 159-160°. Monochlorojuglone,C, yellowish brown needles, purified by carbon tetrachloride, melts at 166°, but gives off a violet vapor above 130°. Acetyl monochlorojuglone,D, brownish yellow plates, recrystallized from alcohol, melts at 147°. Dichlorojuglone,E, lustrous golden brown needles, recrystallized from alcohol, melts at 149°. Acetyl dichlorojuglone,F, yellow plates, recrystallized from alcohol, melts at 154°. Juglone dibromide,G, yellow prisms with pointed ends, recrystallized from ligroin, melts at 109°. Monobromojuglone,H, translucent yellowish brown plates, recrystallized from acetone, melts at 166°. Acetyl monobromojuglone,I, golden brown plates, recrystallized from alcohol, melts at 148°. Tribromojuglone,J, rich red needles, recrystallized from a mixture of chloroform and ligroin, melts at 170°. Acetyl derivative,K, silky yellow needles recrystallized from alcohol, melts at 186°. Monochlorodibromojuglone,M, golden bronze plates, recrystallized from alcohol, melts at 152°. Dihydroxydibromojuglone,N, golden brown prismatic needles, recrystallized from alcohol, melts at 236°. The sodium salt,L, is an indigo blue powder.

CHAPEL HILL, N. C.

OUR RATS, MICE AND SHREWS

BY C. S. BRIMLEY

Rats and mice, both native and introduced, are the most numerous as the most destructive of our mammals, and as shrews are always caught to a greater or less extent when trapping for field mice, I have also added what little information I had about them.

Rats and mice belong to the family Muridæ, and there are no other mammals in this region liable to be confused with them, except the jumping mouse, which, although mouse-like in general appearance, belongs to the Jerboidæ, and is also included in this paper.

Shrews belong to the Insectivora, family Soricidæ, and are characterized by small size, normal limbs, pointed snouts, and an unbroken tooth row, differing markedly in this last respect from rats (and all other rodents) in which there is a wide gap between the incisors and the molars.

The species we get at Raleigh are (1) Introduced Forms: Wharf or Brown Rat, Roof Rat, House Mouse. (2) Native Rats and Mice: White-footed Mouse, Red or Golden Mouse, Ricefield Rat, Harvest Mouse, Cotton Rat, Meadow Mouse, Pine Mouse, Jumping Mouse. (3) Shrews: Southern Shrew, Carolina Mole Shrew, Little Mole Shrew. This make a total of eleven rats and mice and three shrews. One more mouse occurs in the eastern part of the State, and about three more mice and an equal number of shrews in the mountains.

In size the Wharf and Roof Rats class as large rats, the Cotton and Ricefield Rats and the Meadow Mouse as medium sized or rather small rats, the other mice and the shrews do not exceed the size of average or small mice.

In color the three introduced species, the Ricefield Rat and the Harvest Mouse might be said roughly speaking to be mouse colored, the Whitefooted, Red, and Jumping Mice are yellowish brown or tawny, the Meadow Mouse dark brown and the Pine Mouse, chestnut brown. The shrews incline to ashcolored or plumbeous, dark or light, though some of the longtailed forms are more or less chestnut

in color. Their pointed snouts and mole-like fur are characteristic.

Of the introduced species the two large rats are apt to be confused, but weight seems to be diagnostic as the heaviest roof rat I have weighed tipped the scales at only 5 1/2 ounces while the smallest adult wharf rat weighed over 7, and the largest 21 ozs, with an average of not less than 11 or 12 ozs. The tails, too, differ in length, the tail of the roof rat when stretched forward over the back reaching well beyond the nose, while that of the wharf rat does not come much further forward than the ears. Roof rats appear to be more diurnal in habit, and usually seek to escape if possible by climbing upwards while a wharf rat instinctively goes down. Neither species seems to occur in the fields in this locality.

The house mouse occurs both in and around human habitations and in fields far from the haunts of man. It is not likely to be confused with anything else but the harvest mouse, which, however, has much softer fur, a blunter snout, and more distinctly whitish underparts. Fortunately, too, it has a structural difference in that there is a groove down the anterior face of its upper incisors, which is absent in the house mouse.

Of the native species the commonest is the whitefooted or deer mouse, which is not likely to be confused with any other of our Raleigh species except the red mouse from which it differs totally in habits, being terrestrial while the other is an arboreal form. The deer mouse is tawny on the sides with a darker area on the back, the color of the sides and the white of the underparts abruptly distinct, not shading into one another, tail bicolored, white below, tawny above. This species is found everywhere in fields and in woodlands, often forming fifty per cent of the mice and shrews caught when trapping. It seems to nest mostly in rotten stumps or logs either above or below ground.

The species most closely resembling the deer mouse is the red or golden mouse which differs from all the rest of our rats and mice by its arboreal habits. This is a species of low grounds and thickets along streams, building its nests in small trees, reeds or thickets often as high as fifteen feet from the ground. Usually an inspection of the nests will tell if the mouse or mice are at home, as the hole is usually open when they are away, and closed when the inmates are

at home. Each nest is inhabited by a pair of mice with or without a brood of young according to the season of the year, the last brood apparently remaining in the nests with their parents throughout the winter. This is a slightly larger species than the deer mouse, and is more reddish in color, the dark area along the back is less marked and the color of the upper parts shades into the yellowish white of the underparts without a break. The species is never caught in field trapping for mice and I have caught but one in a trap in the woods. The young are colored like the adults unlike those of the deer mouse which are slate colored above.

The commonest of the field mice next to the deer mouse is the little harvest mouse, which occurs as commonly but less uniformly, and does not seem to be found at all in the woods. Its characteristics have been noted in connection with the house mouse.

By far the largest of the field rats and mice is the cotton rat, a stouter built animal and with a proportionately shorter tail than any so far mentioned. This attains a length of from 8 1/2 to over 10 inches with a tail less than two-fifths of its total length, the color is grizzled due to an admixture of yellow tipped hairs with black ones. The species seems to be often very common in honeysuckle tangles on upland ditch banks, and it seems more closely confined to upland fields in this vicinity than any other of our species. Traps for small mice are too small for it, and it will often tear the wooden ones to pieces to get at the bait.

Another good sized species of quite different habits is the rice field rat or rice rat, which casually much resembles a small house rat in appearance. In total length it measures about the same as the cotton rat, but as its tail constitutes about one-half of the total length it is actually much smaller. Its home is in the marshes and cat tail swamps along streams and it swims and dives as readily as a musk-rat, its hind feet being larger in proportion than those of most other mice.

The other two species of Muridæ occurring here are distinguished from all the foregoing by their short ears and very short tails which latter are less than three-tenths of the total length. The larger is the meadow mouse a dark brown good sized mouse mainly inhabiting lowground meadows, but found to a greater or less extent in all up-

land fields, average length about 6 3/4 inches of which the tail constitutes only 2 7/8 inches. This is a potential menace as are all its near relatives to alfalfa and other hay crops.

The smaller of the shorttailed mice occurring here is the pine mouse which is much smaller than the meadow mouse and with still shorter ears and tail. It is more subterranean in its habits than the other mice, both making burrows of its own and following the mole runs under the surface of the ground. It is said to be a more of a woodland species than the other mice, but is captured more or less sporadically in field trapping. In many respects it is a more insidious enemy than our other mice, for the damage it does to potatoes (either kind) or peanuts is not apt to be noticed until the crop is dug and empty shells alone are found.

We now come to the jumping mouse which like the red mouse seems to be untrappable in this locality, though specimens are not infrequently found drowned in the barrels set for muskrats. This is a yellowish species with the coarse harsh fur partly composed of black hairs, and the underparts are yellowish white. The tail is over half of the total length and the hind feet are proportionately very large, its usual method of progression being by leaping like a frog. The species seems to be mostly confined to lowgrounds or the borders of small streams. and is not at all common, Raleigh being, I believe, the most southern locality from which it is known.

Of the shrews there are two groups, the longtailed shrews with the tail more than one-third the total length and the ears more conspicuous, and the short-tailed or mole shrews with the tail less than one-fourth the length and the ears hidden by the fur, the latter look very like diminutive moles, and are often mistaken for young moles by the uninformed in spite of the marked difference in their forefeet from those of a mole.

Of the longtailed shrews we get at Raleigh only one species, the smallest and rarest of our small mammals, *Sorex longirostris,* a little animal only about 3 1/2 inches long of which the tail constitutes 1 1/4, the few specimens taken by me have all been caught in traps in fields, none in woods.

Of the mole shrews we get two species, the Carolina mole shrew, which is about 3 3/4 inches long, the tail only 3/4 inch, and the little mole shrew, which is barely 3 inches long, with the tail 5/8 inch. The latter is usually somewhat paler than the Carolina shrew, but is not always easy to distinguish except by dental characters. Both species are found in fields and the Carolina shrew also in woods, and both can be caught in traps baited with peanuts, which I find to be practically the only bait worth using for field mice and shrews, although the heads of birds and mice can be used to trap shrews and most species of mice.

A few words about trapping small mammals. I find that the best traps to use so far as catching specimens is concerned are the ordinary wooden choker mouse traps, cut in half and set in the runways; the guillotine traps are also good, but shrews and mice seem to have a preference for seeking their food in a hole, thus I have caught cotton-rats in choker traps when their heads were wedged so tight in the hole that it was hard to get them out.

The best season for trapping mice and shrews so far as the number caught is concerned is from about mid-November to Christmas, but those caught later on are in more adult condition and better pelage. As soon as vegetation begins to grow rapidly in the spring the number caught rapidly diminishes, and by early April trapping is about done for.

The following measurements will give some idea of the comparative size and proportions of our species:

Species	Average All Specimens			Average Large Ones			Largest One	
	Number	Total Length	Tail	Number	Total Length	Tail	Total Length	Tail
1. Deer Mouse (*Peromyscus leucopus*).	170	5.75	2.38	26	6.50	2.87	7.00	3.12
2. Golden Mouse (*Peromyscus aureolus*.)	143	6.38	3.00	26	6.93	3.31	7.31	3.63
3. Rice Rat (*Oryzomys palustris*.)	71	8.25	4.06	13	9.81	4.81	10.56	5.25
4. Harvest Mouse (*Reithrodontomys humulis*.)	160	4.56	2.06	32	5.12	2.50	5.56	2.50
5. Cotton Rat (*Sigmodon hispidus*.)	108	8.56	3.38	23	9.93	3.81	10.87	4.50
6. House Mouse (*Mus musculus*.)	21	5.87	2.75	--------	--------	--------	6.75	3.25
7. Roof Rat (*Mus alexandrinus*.)	51	14.25	7.68	11	15.87	8.87	17.12	9.38
8. Wharf Rat (*Mus norvegicus*.)	4	17.25	7.98	--------	--------	--------	20.00	9.50
9. Meadow Mouse (*Microtus pennsylvanicus*).	101	6.81	1.87	10	7.38	2.00	7.93	2.38
10. Pine Mouse (*Pitymys pinetorum*.)	80	4.68	.93	8	5.12	.93	5.12	.93
11. Jumping Mouse (*Zapus hudsonius*.)	23	7.81	4.56	--------	--------	--------	8.68	5.25
12. Southern Shrew (*Sorex longirostris*.)	8	3.38	1.25	--------	--------	--------	3.62	1.44
13. Carolina Mole Shrew (*Blarina Carolinensis*.)	108	3.68	.75	14	3.87	.81	4.06	.93
14. Mole Shrew (*Blarina brevicauda*.)	5	4.68	1.06	--------	--------	--------	5.00	1.06
15. Little Mole Shrew (*Cryptotis parva*.)	93	2.93	.62	11	3.25	.68	3.62	.68

All specimens from Raleigh except 18 Deer Mice, 24 Golden Mice, 10 Harvest Mice, and 15 Little Mole Shrews from Bertie County, N. C., and the 5 Mole Shrews from Buncombe County, N. C.

NOTES ON THE FLORA OF CHURCH'S ISLAND, NORTH CAROLINA

By W. L. McAtee

Church's Island, North Carolina, lies in about the center of Currituck County, which occupies the northeastern corner of the State. It is about four miles long and is bounded on the east by Currituck Sound, on the north by Mills Bay, on the west by Oldtown Creek and on the south by The Creek. The last is scarcely more than a ditch and separates Church's Island from what is called Narrow Shore, along the Sound and from Piney Island farther inland.

Church's Island has a rather high bank along most of the Sound side, and slopes smoothly, though but slightly to the marsh bordering Oldtown Creek on the west. The soil is about the same everywhere, a sandy loam and differences in vegetation are due chiefly to variations in soil moisture. The higher land on the Sound side supports practically all of such trees as red cedar, prickly ash, hackberry, live-oak and Carolina buckthorn. Willow and ash are found only about springy places, while persimmon, mulberry, holly and papaw are rather generally distributed. Loblolly pine, the dominant tree, which fixes the character of landscapes on the island, solidly occupies that part of the island from the marsh to a road running north and south the whole length of the island. Formerly no doubt it similarly dominated land to the east, from which it has been cleared to permit cultivation.

Cultivation has either introduced or opened the way for numerous weeds of which the most conspicuous in fields are fennel, white heath aster, ragweed, redroot, lambs-quarters, Mexican tea, love-grass, partridge pea, morning-glory, butter-print, jimson-weed and *Eupatorium capillifolium*. In gardens purslane, carpet-weed, black nightshade, horse nettle, crabgrass, ribgrass and smartweed are most common. Introduced plants now spontaneous include paper mulberry (*Broussonetia papyrifera*), here bearing the old name Otaheite mulberry, black locust (*Robinia pseudacacia*), crepe myrtle (*Lagerstroemia indica*)*, youpon (*Ilex vomitoria*) and sweet violet (*Viola odorata*).

**Lagerstroemia indica* is usually described as a shrub. However, it makes a tree if given a chance. There are several trees on Church's Island 18 inches in diameter.

The fig *(Ficus carica)* and china-berry *(Melia azedarach)* also are cultivated, but do not appear to reproduce themselves. An interesting series of plants, evidently introduced to Church's Island by commercial operations were discovered about the end of Waterlily wharf and along the road leading from it. These included seaside knotweed, pepper-grass, self-heal, catnip, heliotrope, squash and sow thistle.

The two most prominent plant associations of Church's Island are the marsh and the pine woods. The marshes are of two kinds, (1) smaller spots on the Sound side of the island in which narrow-leaved cat-tail is the dominant growth, and bulrush *(Scirpus validus)*, Baccharis and Iva common, and (2) the marsh into which the whole inland side of the island merges where broad-leaved cat-tail, two species of marshgrass *(Spartina glabra* and *S. polystachya)*, a rush *(Juncus effusus var. solutus)* and a bulrush *(Scirpus robustus)* are most abundant.

In the pine woods, cucumber tree, sweet gum, persimmon and holly are scattered here and there; the most abundant herbs are two grasses: *Uniola laxa* and *Andropogon scoparius*. About the middle of the island is a grove of tall loblolly pines, which has been undisturbed except for grazing in the nine years of its history cognizant to the writer, and probably for a long time before. Aside from the marshes this woods evidently is the nearest to virgin growth of any vegetation on the island. In it were found a number of plants not seen elsewhere, including partridge berry, two kinds of violet *(V. triloba* and *V. septemloba)*, jessamine, creeping cucumber, meadow-beauty *(Rhexia)*, pennywort *(Centella)* and an aster *(A. salicifolius?)*.

The writer's visits to Church's Island have embraced the following periods: August 31 to September 9, and November 24 to December 15, 1909, and October 10-21, 1918. Collecting plants, except the aquatics occupied only a small part of the whole time. This fact together with the unfavorable season for botanizing renders the following list incomplete. Nevertheless it is hoped that these notes will have some value since they refer to a region for which no local flora has been published.

The writer greatly appreciates the assistance of Mrs. Agnes Chase, W. R. Maxon, S. F. Blake and G. P. Van Eseltine in determining plants of groups in which they specialize. For other names in the list the writer is responsible, and those of Aster and Solidago should be treated with reserve. Of the English names given the first is the book or otherwise recognized name, if there is a worthy one; any others are local names in use on Church's Island. The authorities for botanical names are spelled out except in the case of Linnæus who named so large a proportion of plants of the Middle Atlantic States. Notes are included on the stage of flowering or fruiting observed, data which is lacking in too many local lists. For this purpose the following abbreviations are used: fl., flower; fr., fruit; imm., immature; mat., mature. When fr. only is used maturity is to be assumed. When no month accompanies these notations October is to be understood.

LIST OF PLANTS

Subkingdom Euthallopthyta (Algæ, etc.)

Chara spp. Muskgrass, nigger wool, oyster grass. Blankets the bottom of almost the whole of Currituck Sound; oögonia, August—October.

Subkingdom Pteridophyta (Ferns, etc.)

FAMILY OSMUNDACEÆ

Osmunda regalis L. Royal fern, a few plants seen, in marsh and other wet places.

FAMILY POLYPODIACEÆ

Dryopteris thelypteris (L.) A. Gray. Marsh Shield-fern.; common in marsh.

Polypodium polypodioides (L.) A. S. Hitchcock. Gray Polypody. A few plants seen on trunk of sweet gum.

Subkingdom Spermatophyta. (Seed plants.)

FAMILY PINACEÆ

Pinus tæda L. Loblolly pine. The dominant tree of the island, reproduction admirable; produces wood enough for the requirements of the island without diminution of the stand. The fallen needles are carefully gathered for use as a stable litter; in this state they are called straw or pine-straw.

Juniperus virginana L. Red cedar. Common along high bank of Sound; less so elsewhere, but grows even in edge of marsh; some specimens dwarfed by grazing are very dense and remarkable in appearance; fr.

FAMILY TYPHACEÆ

Typha latifolia L. Broad-leaved cat-tail. Abundant in marsh forming inner side of island.

Typha angustifolia L. Narrow-leaved cat-tail. The principal constituent of marshy patches bordering Sound.

FAMILY ZANNICHELLIACEÆ

Potamogeton perfoliatus L. Clasping-leaved pondweed, redhead grass. Common in Sound, especially over muddy bottoms.

Potamogeton foliosus Rafinesque. Leafy pondweed. Scarce in Sound; common in ponds and streams of marsh.

Potamogeton pectinatus L. Sago pondweed; foxtail grass; extremely abundant in Sound; the dominant plant; fr. Aug.-Oct.

Ruppia maritima L. Wigeon grass. Scattered in Sound; apparently not as common as in 1909. Ripe akenes Sept.

FAMILY NAIADACEÆ

Naias flexilis (Willdenow) Rostkovius and Schmidt. Bushy pondweed. Abundant in Sound.

FAMILY ALISMACEÆ

Sagittaria latifolia Willdenow. Wapato. Common in marsh.

Sagittaria teres Watson. Goose grass. In 1909 this was abundant in very shallow water along shore of Sound; in 1918 I did not see it; fl. Sept.

Sagittaris graminea Michaux. Scarce in shoal water of Sound; fls. Sept.

Sagittaria subulata (L.) Buchenau. Abundant on mud along edge of marsh. fls.

FAMILY VALLISNERIACEÆ

Philotria canadensis (Michaux) Britton. Waterweed. Scattering near shore in Sound.

Vallisneria spiralis L. Wild celery. Abundant in Sound; especially along channels and in places over soft muddy bottom; also in creeks in marsh; fls. Aug.-Sept., fr. October.

FAMILY GRAMINEÆ

Erianthus saccharoides Michaux. Plume grass. Scattered in marsh; mat. fr.

Schizachyrium scoparium (Michaux) Nash. Broom beard-grass. Common; mat. fr.

Andropogon virginicus L. Broom-sedge. Common; mat. fr.

Syntherisma sanguinale (L.) Dulac. Crab-grass. Abundant weed in fields; mat. fr.

Paspalum longipilum Nash. In old pine woods; mat. fr.

Paspalum distichum L. Joint grass. Along roads.

Echinochloa crusgalli (L) Beauvois. Common, along ditches; fr.

Panicum dichotomiflorum Michaux. Common in woods; fruit mostly fallen.
Panicum virgatum L. Switch grass. Common.
Panicum anceps Michaux. In old pine woods; mat. fr.
Panicum condensum Nash. Common along ditches and other wet places; fr.
Panicum longifolium Torrey. In woods near marsh; mat. fr.
Panicum ciliatum Elliott. Wet woods near marsh; fr. mostly fallen.
Panicum roanokense Ashe. In woods near marsh; fr. mostly fallen.
Panicum scoparium Lamarck. Common in wet places.
Chætochloa viridis (L.) Scribner. Green foxtail. Common weed; fr.
Muhlenbergia schreberi Gmelin. Scarce in woods.
Cinna arundinacea L. Reed-grass. Along ditches; mat. fr.
Spartina polystachya Elliott. Along ditches and creeks in marsh.
Spartina glabra Muhlenberg. One of the chief components of the marsh; mat. fr.
Eleusine indica (L.) Gærtner. Yard-grass. Common weed in gardens; also along roads.
Eragrostis ciliaris (L.) Link. Abundant weed in fields; glumes empty.
Uniola laxa (L.) Britton, Sterns and Poggenburg. Abundant in woods; mat. fr.
Distichlis spicata (L.) Greene. Salt-grass. Abundant in marsh, and along ditches; fr.
Elymus virginicus L. Wild rye. A single colony seen in yard of old abandoned homestead. mat. fr.
Arundinaria tecta (Walter) Muhlenberg. Maiden cane. Not common.

FAMILY CYPERACEÆ

Cyperus diandrus Torrey. Marsh. mat. fr.
Cyperus rivularis Kunth. About Waterlily wharf and road, also edge of marsh; mat. fr.
Cyperus dentatus Torrey. About Waterlily wharf and road. mat. fr.
Cyperus erythrorhizos Muhlenberg. Common.
Cyperus strigosus L. Common; mat. fr. Sept.-Oct.
Cyperus lancastriensis Porter. Weed, fls. to mat. fr.
Cyperus hystricinus Fernald. Pine woods; mat. fr.
Cyperus ovularis (Michaux) Torrey. Old pine woods; mat. fr.
Cyperus cayennensis (Lamarck) Britton. In woods near marsh; mat. fr.
Cyperus globulosus Aublet. Weed in corn field; mat. fr.
Eleocharis obtusa (Willdenow) Schultes. Common, edge of Marsh; mat. fr.
Eleocharis tuberculosa (Michaux) Rœmer and Schultes. Common in marsh; mat. fr.
Scirpus validus Vahl. Great bulrush. Common in marshy patches bordering Sound; mat. fr.
Scirpus robustus Pursh. Abundant in marsh.
Fuirena hispida Elliott. Scarce in marsh.
Carex festucacea Willdenow. Common in woods; mat. fr.
Carex albolutescens Schweinitz. In old pine woods; mat. fr.

FAMILY LEMNACEÆ

Lemna minor L. Duckweed. Abundant along edge of marsh.

FAMILY JUNCACEÆ

Juncus effusus L. var. solutus Fernald and Wiegand. One of the principal components of the marsh; produces very little fruit.
Juncus tenuis Willdenow. Scattered along roads; fr.
Juncus setaceus Rostkovius. In wet places, pine woods; fr.
Juncus marginatus Rostkovius. Common in marsh; fr.
Juncus canadensis J. Gay. Common in marsh; fr.
Juncus acuminatus Michaux. Scattered in pine woods; fr.

FAMILY PONTEDERIACEÆ

Pontederria cordata L. Pickerel-weed. Common along edge of marsh.

FAMILY SMILACACEÆ

Smilax herbacea L. Carrion flower. Fruit collected Nov. 1909.
Smilax glauca Walter. Greenbrier. Common; fr.
Smilax rotundifolia L. Common; fr.
Smilax bona-nox L. Common; fr.

FAMILY AMARYLLIDACEÆ

Hypoxis hirsuta (L.) Coville. Yellow Star-grass. Scattered near edge of marsh. Fls.

FAMILY ORCHIDACEÆ

Ibidium ovale (Lindley) House. Common in marsh. Fls.

FAMILY SAURURACEÆ

Saururus cernuus L. Lizard's tail. Common along edge of marsh.

FAMILY JULANDACEÆ

Juglans nigra L. Black Walnut. A few tree present.

FAMILY MYRICACEÆ

Myrica carolinensis Miller. Abundant, occurring on almost all parts of the island; becomes a tree; a specimen 25 feet high with trunk a foot in diameter seen.

FAMILY SALICACEÆ

Salix nigra Marsh. Willow. Scattered about wet spots particularly along shore of Sound.

FAMILY FAGACEÆ

Quercus virginiana Miller. Live Oak. Only one seen on high shore of Sound.

FAMILY ULMACEÆ

Celtis mississippiensis Bosc. Hackberry. Common along high shore of Sound; fr. Sept.-Oct.

FAMILY MORACEÆ

Morus rubra L. Red mulberry. A few trees, in pine woods and on high shore of Sound.

FAMILY URTICACEÆ

Pilea pumila (L.) A. Gray. Rich-weed. In wet places.
Bœhmeria cylindrica (L.) Swartz. Collected in fruit; Sept. 1909.

FAMILY POLYGONACEÆ

Rumex crispus L. Sour dock. Common weed. Mat. fr.
Polygonum maritimum L. Seaside knotweed. A few plants about Waterlily wharf, Fl. to mat. fr.
Tovara virginiana (L.) Rafinesque. Common along woodland road; mat. fr., Sept.-Oct.
Polygonum lapathifolium (L.) S. F. Gray. Common weed; fr.
Persicaria pennsylvanica (L.) Small. Smartweed; common weed in gardens; mat. fr. Sept.-Oct.
Persicaria hydropiperoides (Michaux) Small. Marsh. Mat. fr.
Persicaria punctata (L.) Opiz. Water pepper. Common in marsh, and wet places in general. Fls. to mat. fr. August to October.
Tracaulon sagittatum (L.) Small. Common along edge of marsh.
Tracaulon arifolium (L.) Rafinesque. Edge of marsh. Immature and mature akenes Sept. 1909.
Tiniaria scandens (L.) Small. Climbing false buckwheat. Common.

FAMILY AMARANTHACEÆ

Amaranthus retroflexus L. Redroot. Common weed; fls. to mat. fr.

FAMILY CHENOPODIACEÆ

Chenopodium album L. Lambs-quarters. Common weed.
Chenopodium ambrosioides L. Mexican tea. Common weed; fls. to fr.

FAMILY PHYTOLACCACEÆ

Phytolacca americana L. Poke-weed. Common, fr.

FAMILY AIZOACEÆ

Mollugo verticillata L. Carpetweed. Common in gardens; fls. to fr.

FAMILY PORTULACACEÆ

Portulaca oleracea L. Purslane. Common weed in gardens.

FAMILY NYMPHAEACEÆ

Castalia odorata (Dryand) Woodville and Wood. White Waterlily. Common in pools along edge of marsh.

FAMILY MAGNOLIACEÆ

Magnolia virginiana L. Sweet Bay. Not common; fr. Sept.
Magnolia acuminata L. Cucumber tree. A few trees in pine woods.

FAMILY ANNONACEÆ

Asimina triloba (L.) Dunal. Papaw. Scattered in pine woods; fruit ripe in September, fallen by October; evidently does not require frost for ripening as believed in some localities north; the same remark applies to persimmons. On my first visit to Church's Island, in 1909, I found to my surprise that papaws were not only not eaten by the inhabitants, but were actually regarded as poisonous.

FAMILY RANUNCULACEÆ

Clematis virginiana L. Common; fr.

FAMILY CRUCIFERÆ

Lepidium virginicum L. Pepper-grass. Waterlily road. Fls. to mat. fr.

FAMILY ALTINGIACEÆ

Liquidambar styraciflua L. Sweet Gum. Scattered; more at the north end than elsewhere.

FAMILY ROSACEÆ

Rubus trivialis Michaux. Blackberry. Common.
Rosa carolina L. Swamp rose. Common in edge of marsh and other wet places; fls. to mat. fr.

FAMILY MALACEÆ

Cratægus crus-galli L. Red haw. One tree; Oct. fruit not yet ripe.

FAMILY AMYGDALACEÆ

Prunus americana Marsh. Wild plum. Common.
Prunus angustifolia Marsh. Chickasaw Plum. Common.
Padus virginiana (L.) Miller. Wild Black Cherry. A few seen.

FAMILY CÆSALPINACEÆ

Chamæcrista fasciculata (Michaux) Greene. Abundant; fr.
Gleditsia triacanthos L. Honey Locust. A few trees on high bank near Sound.

FAMILY FABACEÆ

Trifolium repens L. White clover. Common weed.
Lespedeza striata (Thunberg) Hooker and Arnott. Japan clover. Common weed; mat. fr.
Glycine apios L. Ground nut.
Strophostyles helvola (L.) Britton. Wild bean. Waterlily wharf; mat. fr.
Strophostyles umbellata (Muhlenberg) Britton. Weed in cornfield; pods dehisced.

FAMILY OXALIDACEÆ

Xanthoxalis corniculata (Linnæus) Small. Common near shore about middle of island; fls. to fr.

FAMILY BALSAMINACEÆ

Impatiens biflora Walter. Touch-me-not. A few seen; fls. to fr.

FAMILY RUTACEÆ

Zanthoxylum clava-herculis L. Prickly ash, Pillenterry; common; fr.

FAMILY EUPHORBIACEÆ

Acalypha virginica L. Mercury weed. Common; mat. fr.
Acalypha gracilens A. Gray. In old pine woods; mat. fr.
Chamæsyce preslii (Gussone) Arthur. Spurge. Occasional; mat. fr.

FAMILY ANACARDIACEÆ

Rhus copallina L. Dwarf sumach. Common; fr.
Toxicodendron radicans (L.) Kuntze. Poison Ivy, Shoe-string weed; common; fr.

FAMILY ILICACEÆ

Ilex opaca Aiton. Holly. Scattered in pine woods.
Ilex vomitoria Aiton. Youpon. Perhaps native as a few trees were found in a wet thicket, but most of the hollies of this species on the island were planted, the leaves being commonly used in making tea. Native on Knotts Id., and on the beach at least to the neighborhood of Princess Anne, Va.

FAMILY ACERACEÆ

Acer rubrum L. Red maple. Common.

FAMILY RHAMNACEÆ

Berchemia scandens (Hill) Trelease. Rattan vine. Common; fr.

FAMILY VITACEÆ

Vitis æstivalis Michaux. Summer Grape. Scarce; fr. Sept.
Vitis rotundifolia Michaux. Bullace grape. Common; fr. Sept.
Ampelopsis arborea (L.) Rusby. Peppervine. Common; fr.
Parthenocissus quinquefolia (L.) Planchon. Virginia Creeper. Common.

FAMILY MALVACEÆ

Abutilon abutilon (L.) Rusby. Butter-print. Common; fr.
Hibiscus militaris Cavanilles. Common in marsh; mat. fr.

FAMILY HYPERICACEÆ

Ascyrum hypericoides L. St. Andrews Cross. Pine woods; fr.
Hypericum perforatum L. mat. fr.
Hypericum mutilum L. Common in woods near marsh; fls. to mat. fr.

FAMILY VIOLACEÆ

Viola triloba Schweinitz. In old pine woods; mat. fr.
Viola septemloba Le Conte. In old pine woods; capsules empty.
Viola odorata L. Sweet Violet. Yard, spontaneous. Fls.

FAMILY PASSIFLORACEÆ

Passiflora incarnata I. Passion flower, May-pop; pop-apple; common; fls. and fr. in September; fr. only in October.
Passiflora lutea L. Common; twining in thickets; fr.

FAMILY CACTACEÆ

Opuntia pollardi Britton and Rose. Prickly Pear. A large colony on shore of Sound near old pine woods; fruit, Sept.-Oct.

FAMILY LYTHRACEÆ

Ammannia kœhnei Britton. Marsh; mat. fr.
Decodon verticillata (L.) Elliott. Immature to ripe fruit Sept., 1909; not seen in 1918.

FAMILY MELASTOMACEÆ

Rhexia mariana L. Pine woods; fr.

FAMILY ONAGRACEÆ

Oenothera biennis L. Evening Primrose. Common weed; fr.

FAMILY HALORAGIDACEÆ

Proserpinaca pectinata Lamarck. Mermaid weed. Common on mud along edge of marsh.

Myriophyllum sp. Common in ditches at South End.

FAMILY ARALIACEÆ

Aralia spinosa L. Hercules' Club. Scarce; wet thickets.

FAMILY AMMIACEÆ

Sanicula canadensis L. Snake root. Basal leaves in old pine woods.

Fœniculum fœniculum (L) Karsten. Fennel. A very common weed; fr. both September and October.

Hydrocotyle umbellata L. Marsh pennywort. Abundant, mudflats along edge of marsh. Fls. to mat. fr.

Hydrocotyle ranunculoides L. Common along paths, and edges of marsh; fr.

Centella asiatica (L.) Urban. Old pine woods; mat. fr.

Ptilimnium capillaceum (Michaux) Rafinesque. Scarce in marsh. Fls. to mat. fr.

Cicuta maculata L. Water hemlock. Common; fr.

FAMILY CORNACEÆ

Cornus asperifolia Michaux. Common; fr.

Nyssa sylvatica Marsh. Sour Gum. A few trees in wet woods; fr. Sept.-Oct.

FAMILY SAPOTACEÆ

Bumelia lycioides (L.) Persoon. Carolina Buckthorn. Common along high shore of Sound; fr.

FAMILY EBENACEÆ

Diospyros virginiana L. Persimmon. Common; here as elsewhere the fruit varies much in quality, that of some trees being excellent.

FAMILY OLEACEÆ

Fraxinus americana L. White ash. A few trees in springy place; leaflets broadly ovate, much shorter and broader than on white ash in the vicinity of Washington, D. C.

FAMILY LOGANIACEÆ

Gelsemium sempervirens (L.) Aiton. Yellow Jessamine. Common in old pine woods.

FAMILY GENTIANACEÆ

Sabbatia dodecandra (L.) Britton, Sterns and Poggenburg. Marsh pink. One very old and damaged specimen in edge of marsh.

FAMILY ASCLEPIADACEÆ

Asclepias rubra L. Scattered in distribution.

FAMILY CONVOLVULACEÆ

Ipomœa hederacea Jacquin. Morning Glory. Weed in gardens and fields; fls. to fr.

FAMILY CUSCUTACEÆ

Cuscuta sp. Dodder noted but not identified.

FAMILY BORAGINACEÆ

Heliotropium indicum L. Heliotrope. Waterlily Road. Fls. to mat. fr.

FAMILY VERBENACEÆ

Verbena urticifolia L. Occasional weed; fls. to mat. fr.
Lippia nodiflora (L.) Michaux. Flowers to ripe fruit, Sept.
Callicarpa americana L. French Mulberry. Of scattering distribution; a specimen of tree form 15 feet high, with the trunk 3 inches in diameter seen; fr. both September and October.

FAMILY LABIATÆ

Teucrium canadense L. Fls.
Marrubium vulgare L. Hoarhound. Common about houses. Fls. to mat. fr.
Nepeta cataria L. Catnip. Near Waterlily Wharf.
Prunella vulgaris L. Self-heal. Waterlily Road; fls. to fr.
Monarda punctata L. Horse mint. Common.
Lycopus virginicus L. Bugle-weed. Common along shore of Sound; mat. fr.
Mentha spicata L.. Spearmint. Fls. Sept., 1909.
Perilla frutescens (L.) Britton. Common; fr.

FAMILY SOLANACEÆ

Solanum nigrum L. Nightshade. Common; fr.
Solanum carolinense L. Horse nettle; Common; fr.
Datura stramonium L. Jimson Weed. Common; fr.

FAMILY SCROPHULARIACEÆ

Verbascum thapsus L. Mullen. Of scattering distribution; not common.
Agalinis purpurea (L.) Britton. Common; fls. to fr.

FAMILY BIGNONIACEÆ

Bignonia radicans L. Trumpet creeper. Common; fr.

FAMILY ACANTHACEÆ

Ruellia strepens L. Scarce. Flowers Sept.-Oct.

FAMILY PLANTAGINACEÆ

Plantago major L. Common Plantain. Common weed.
Plantago lanceolata L. Ribgrass. Common weed in gardens.

FAMILY RUBIACEÆ

Oldenlandia uniflora L. Scattered in distribution; mat. fr.
Mitchella repens L. Partridge Berry. In old pine woods; fr.
Diodia teres Walter. Button weed. Common weed. Mat. fr.
Diodia virginiana L. Flowers to mat. fruit Sept.
Galium pilosum Aiton. Shore near pine woods. Mat. fr.
Galium claytoni Michaux. Marsh.

FAMILY CAPRIFOLIACEÆ

Sambucus canadensis L. Elder. Common.

FAMILY CUCURBITACEÆ

Cucurbita moschata Duchesne. Squash. One plant near Waterlily Wharf; fl.
Cucumis melo L. Muskmelon. A few small plants in wet ground near marsh; fls.
Melothria pendula L. Creeping cucumber. Old pine woods; mat. fr.

FAMILY LOBELIACEÆ

Lobelia syphilitica L. Marsh; fr.
Lobelia amœna Michaux. Wet places; fls. to fr.
Lobelia elongata Small. Marsh. Fls. to fr.

FAMILY CICHORIACEÆ

Sonchus arvensis L. Sow thistle. A few rosettes of basal leaves near Waterlily Wharf.
Hieracium marianum Willdenow. Basal leaves common in and near old pine woods; one plant in flower and fruit.

FAMILY AMBROSIACEÆ

Iva frutescens L. Of scattering distribution.
Ambrosia elatior L. Ragweed. Abundant weed.
Xanthium americanum Walter. Cocklebur. Common weed. Mat. fr.

FAMILY COMPOSITÆ

Elephantopus carolinianus Willdenow. Common in woods bordering marsh, and along road.

Eupatorium capillifolium (Lamarck) Small. Abundant, here about equal in abundance to ragweed; in coastal states farther south it quite usurps the haunts and dominance among weeds of ragweed in the north.

Eupatorium serotinum Michaux. Waterlily Road and adjacent woods. Fls. to ripe akenes.

Eupatorium perfoliatum L. Boneset. Scarce.

Eupatorium cœlestinum L. Mist-flower. Common; fls. to fr.

Mikania scandens (L.) Willdenow. Common running over shrubs in wet places, also trailing on ground in old pine woods.

Solidago altissima L. Goldenrod. Common; fls. to fr.

Solidago serotina Aiton. Common; fls. to fr.

Euthamia minor (Michaux) Greene. Abundant; fls. to fr.

Euthamia graminifolia (L.) Nuttall. The broader leaved and less common kind. Waterlily Road. Fls.

Aster puniceus L. Common in marsh and swamp spots; fls. to fr.

Aster salicifolius Lamarck? Trailing form in old pine woods; fl.

Aster ericoides L. White Heath Aster. Omnipresent and very abundant.

Baccharis halimifolia L. Common.

Pluchea camphorata (L.) De Candolle. Pink-top Smartweed. Common; fls. to fr.

Anaphalis margaritacea (L.) Bentham and Hooker. Everlasting. Common.

Polymnia uvedalia L. Leaf-cup. Common in waste places; fls. to mat. fr.

Phæthusa occidentalis (L.) Britton. Common in waste places. Fls. to fr.

Coreopsis verticillata L. Common. Fls.

Bidens lævis (L.) Britton, Sterns and Poggenburg. Bur Marigold. Common in woods along edge of marsh. Fls. to fr.

Bidens bipinnata L. Spanish Needles. Common. Mat. fr.

Bidens trichosperma (Michaux) Britton. Common in marsh; fls. to mat. fr.

Erechtites hieracifolia (L.) Rafinesque. Scattered in all parts of island; mat. fr.

Cirsium lanceolatum (L.) Hill. Thistle. Fairly common; fls. to fr.

In connection with the above list it may be well to place on record the names of plants collected at other points in Currituck County.

POPLAR BRANCH, SEPT. 3, 1909

Decodon verticillatus. fls., imm. fr.; Jussiæa decurrens. fls., imm. fr.

NARROWS ID., SEPT. 3, 1909

Potamogeton pectinatus. Ruppia maritima, Naias flexilis, Vallisneria spiralis, Sagittaria lancifolia. fls. imm. fr.; Asclepias pulchra. fls.

CURRITUCK CLUB, SEPT. 3, 1909

Typha angustifolia, Potamogeton perfoliatus, Potamogeton pectinatus, Ruppia maritima, Naias flexilis, Philotria canadensis, Vallisneria spiralis, Echinochloa crusgalli longearistata, mat. fr.; Spartina polystachya, Cyperus microdontus, Cyperus rotundus, Cyperus erythrorhizos, Fimbristylis castanea, mat. fr.; Scirpus robustus, mat. fr.; Juncus scirpoides, Rumex verticillatus, Persicaria punctata, Acnida cannabina, Portulaca oleracea; mat. fr.; Ceratophyllum demersum, Kosteletzkya virginica, fls.; Hydrocotyle umbellata, Ptilimnium capillaceum, imm. fr.; Lobelia glandulosa, fls.; Mikania scandens, mat. fr.; Pluchea camphorata, fls.

CURRITUCK INLET, SEPT. 4, 1909

Cyperus flavescens, Scirpus debilis, mat. fr., Juncus megacephalus, Salsola kali, mat. fr.; Sabbatia angustifolia, fis.; Physalis viscosa, fis. imm. fr.; Pluchea camphorata, fls.

WASHINGTON, D. C.

THE DISTRIBUTION OF RHODODENDRON CATAWBIENSE, WITH REMARKS ON A NEW FORM.

By W. C. Coker

Plates 19, 20, 21 and 22.

Rhododendron catawbiense was discovered by John Fraser, the indefatigable English explorer, on the top of Roan Mountain in 1799. Sent to England by him it was there greatly admired and soon established itself as one of the most popular of cultivated plants. It has been much hybridized by skillful breeders and its blood is now to be distinguished in many of the splendid hybrid Rhododendrons so extensively used today.

The actual distribution of the species and its forms is one of the most remarkable and puzzling of which we have record, and not less remarkable is the ignorance among botanists of the extent of this distribution. The manuals covering this territory confine the species to the mountains. Gray's Manual, Seventh Edition, says "High Alleghanies, Va., to Ga;" Small's Flora of the Southeastern United States says "On mountain slopes Virginia to West Virginia, Georgia and Alabama." Dr. M. A. Curtis in his Catalogue of North Carolina Woody Plants makes the inexplicable mistake of considering the Orange County plant as *R. maximum*, although it existed in quantity on the hills directly across the river from his home at Hillsboro. He says of *R. maximum* that it grows as "far east as Orange," while of *R. catawbiense* he says, "It is often confounded with the preceding [*R. maximum*], but besides its different locality, growing only on the tops of such mountains as the Roan in Yancey and Negro Mountain in Ashe, it blossoms earlier than the other, though at a higher elevation, has larger and more intensely colored flowers, and shorter and broader leaves."

The only published records that I have been able to find of the occurrence of *R. catawbiense* elsewhere in North Carolina than on the tops of the high mountains are by Dr. Asa Gray, Prof. F. W. Simmons, and by Dr. John K. Small. Dr. Gray was sent specimens in flower by Prof. Simmons from Chapel Hill and in

PLATE 19

RHODODENDRON CATAWBIENSE FORM INSULARIS
From Chapel Hill, May 12, 1914
Reduced

his *Notes of a Botanical Excursion into North Carolina,* says in a footnote: "Our own observations would restrict *Rhododendron Catawbiense* to the tops of the higher mountains, or to some such peculiar station as this at Linville Falls at somewhat lower elevations. But Mr. Howard Shriver pointed out to me a locality at the foot of the low mountains which rise behind Wytheville in Virginia; and, what is truly extraordinary, Prof. F. W. Symonds, of the University of North Carolina, sends specimens, in full bloom on the third of April, on a steep and shaded bank on Morgan's Creek, near Chapel Hill, in the middle upper country of the State, flourishing at an elevation of only 500 feet above the level of the sea!" (Bull. T. B. Club **6**: 336. 1879). A little later in the same year Professor Simmons published a note *On the Habitat of Rhododendron catawbiense,* in which he records its occurrence at Chapel Hill (Am. Naturalist, Dec. 1879, p. 777). He quotes from Dr. Gray's letter to him on receipt of specimens, as follows: "The laurel (which I had heard of from one of your pupils whom I met in June) I am delighted to see. It is certainly, as you say, *R. catawbiense,* and most remarkable for occurring at so low a level, where it flowers early. It comes down somewhat as *R. punctatum* does in Georgia. But this is *more remarkable.*" These early records seem to have been entirely forgotten, for they have never found their way even into Gray's own Manual. More recently Dr. Small has collected *R. catawbiense* on Kings Mountain, one of the points we visited (Torreya **1**: 7. 1901).

At Chapel Hill, at Hillsboro, at Patterson's Mill in Orange County, and about eight miles north of Durham, at Christian's Mill near the Roxboro road in Durham County this Rhododendron grows in flourishing abundance on the steep, northward-facing banks and bluffs of Morgan's Creek, New Hope Creek, and Eno River.

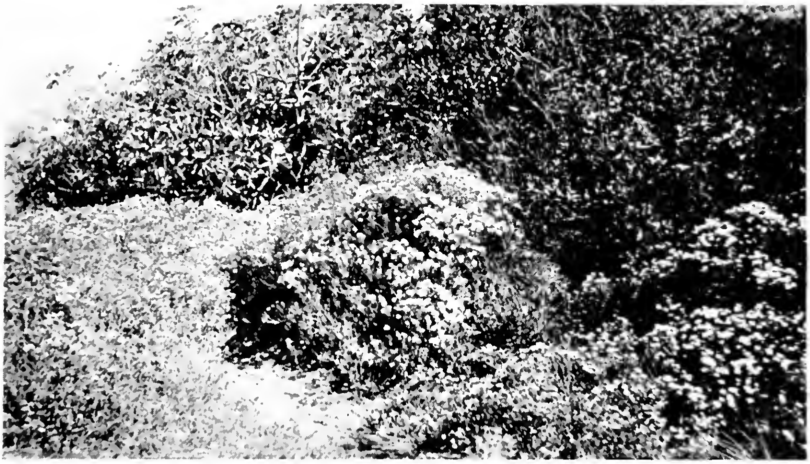
Surprising as these occurrences may seem we can now report still more remarkable extensions of the range. In 1908 I secured specimens of *R. catawbiense* in bloom that were collected by Mr. W. J. Andrews of Raleigh from his farm, one mile west of Cary. It grew in plenty on the south bluff of Crabtree Creek. A little later I heard rumors of the occurrence of Rhododendron at Selma, and made a

trip there to locate it. Driving out to the banks of the Neuse River about 4 miles north of town I found *Rhododendron catawbiense* in full bloom, and quite abundant on a steep bluff on the south side of the river, a position exactly similar to its station in Chapel Hill. This record extends the species to the middle of the coastal plain and down to an elevation of about 150 feet above the sea.

There seems to be no published record of the occurrence of this species between the tops of the high mountains of the main ranges and Orange County except from Kings Mountain, as mentioned above, and from Table Rock by Nuttall (Genera of N. Am. Plants **2**: 5. 1818) who records it from the "romantic summit" in company with his interesting *Hudsonia montana*, which seems to be confined to this place. To these records we can now add Crowders Mountain, near Kings Mountain, these two being abrupt eminences in Gaston County near the South Carolina line and about sixty miles from the nearest high mountains. Dr. Small visited Table Rock July 2, 1891, but failed to notice *R. catawbiense* there (Mem. Tor. Bot. Club **3**: 10. 1892). It is also very strange that Dr. Asa Gray and his large party who ascended Table Rock on June 12, 1879, failed to recognize this species (Bull. Tor. Bot. Club **6**: 335. 1879). The plants had flowered about a month before their arrival and they must have carelessly taken it for *R. punctatum* or *R. maximum*. They report only the former. It is interesting to note that they found on the same trip that *R. catawbiense* was just coming into bloom on Roan Mountain on June 16th.

In May of this year the writer with three of his students took an automobile trip to the three mountains just mentioned to ascertain what species of Rhododendron grew on them and to look for Rhododendron in other places. Rehder has reported (from Small's collections) *R. carolinianum* and *R. minus* from *Table Rock* (Rhodora **14**: 97. 1912). We found the former in abundance and in full bloom, but did not see the latter. There was also an abundance of *R. catawbiense* in bloom on the top (elevation about 3,900 feet) and on the sides in small amount down to perhaps 2,500 feet. Near the top but not on it a few clumps of *R. maximum* were seen.

PLATE 20



DENDRIUM PROSTRATUM (above)
RHODODENDRON CATAWBIENSE (below)
Both from top of Table Rock, May 18, 1919

PLATE 21

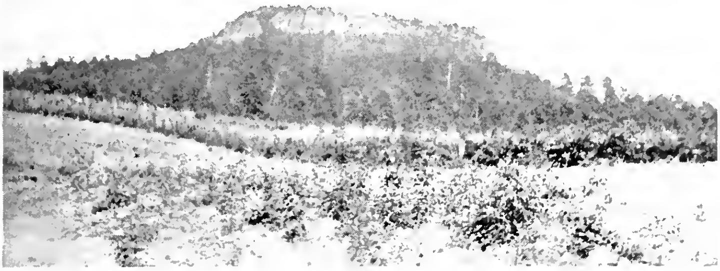


TABLE ROCK (above)
KINGS MOUNTAIN (middle)
CROWDERS MOUNTAIN (below)

Leaving Table Rock we went south to Lincolnton where we were told that Rhododendron grew on the Little Catawba. It proved, as is so often the case, to be only Kalmia. Continuing south to near the South Carolina line we ascended Kings Mountain (950 feet) and Crowders Mountain (1,600 feet). On the first was a fine display of *R. catawbiense* in full bloom in crevices, ledges and gorges along the precipitous faces. It was interesting to find that there was associated with Rhododendron here *Forthergilla major,* as is also the case in Chapel Hill. The conditions on Crowders Mountain were about the same. There was only a very little *R. catawbiense* on the northern peak, but more on the higher central peak. No other species of Rhododendron was seen on either mountain.

From reliable observers (Mrs. Harper and Miss Goforth) we find that *R. catawbiense* grows about three to four miles west of Lenoir on a small elevation called Peaky Top and on hills around Harper Town, about two miles west of Lenoir. There are also said to be scattered patches in the valley between Black Mountain and Montreat (elevation of about 2,100 feet), and Mr. F. M. Crayton, formerly of the Biltmore Nursery, has told me that it occurs at the foot of Craggy Mountain on the east side and down the east side of a number of other mountains to an altitude less than two thousand feet. It would seem that this species descends to about 2,000 feet down the eastward slopes of the Blue Ridge and Alleghenies, but that it does not descend down the western slopes.

Notwithstanding the extension of the range of this species in the mountain region down to Table Rock and Kings and Crowders Mountains we still have remaining the very remarkable fact that in the center of the State is a group of stations separated from the nearest ones to the westward by about 140 to 210 miles. The question naturally arises: Is the plant of the central region the same as the mountain one or is it a variety of it, or a different species? For several years I have been trying to get the mountain form to bloom in Chapel Hill to compare side by side with the Chapel Hill form, and this spring was successful. Flowers of the mountain form (obtained from Highlands Nursery) were like ours except that they were broader in proportion to width than most of ours. The flowers of the Chapel Hill

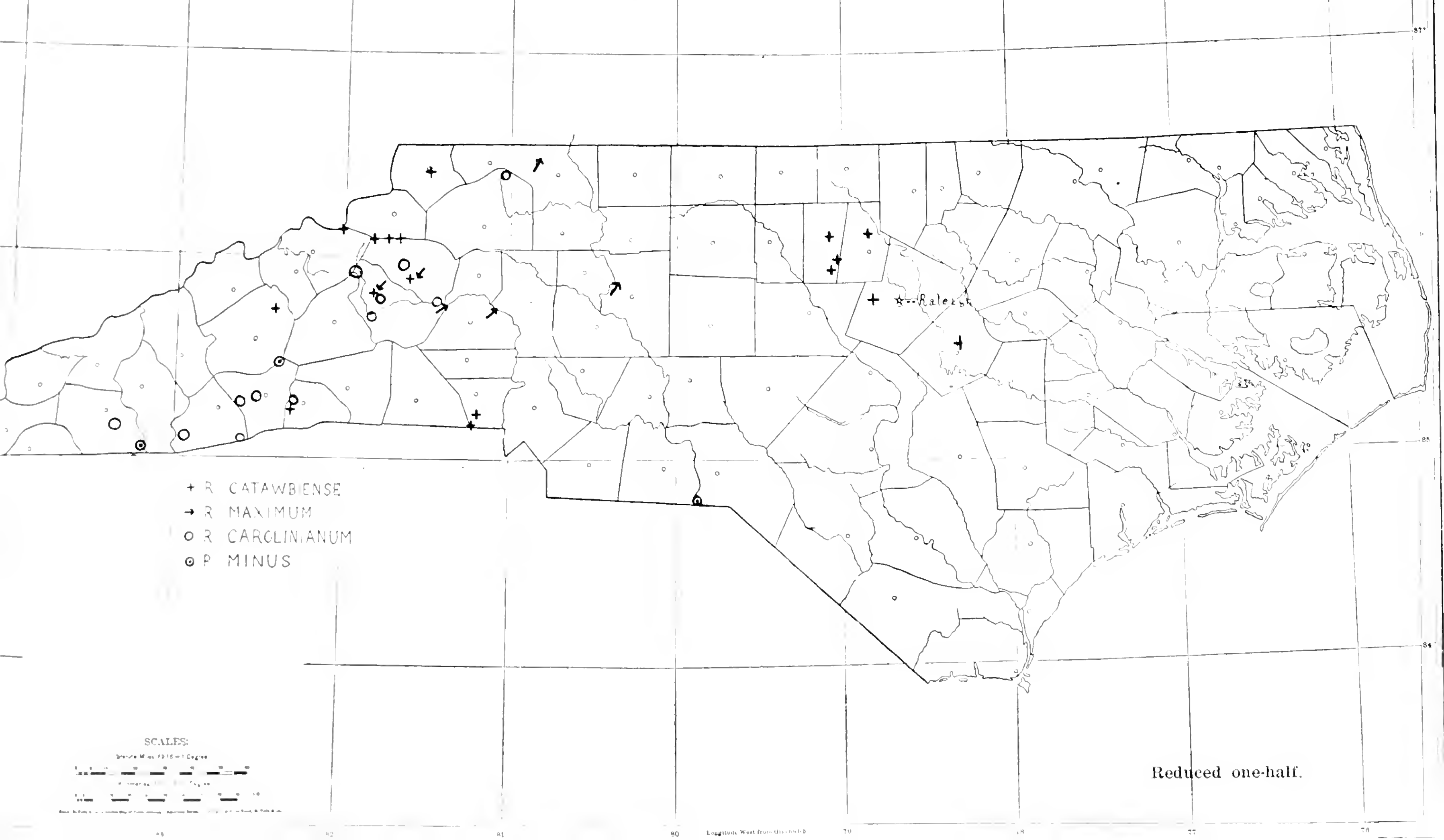
plants averaged 1.1 times broader than long, while the flowers of the nursery plant were 1.4 times broader than long. The flowers of the Table Rock plant were not to be distinguished from the nursery plant, being open and broad, but the two Crowders Mountain plants found in bloom had longer flowers like the Chapel Hill ones and were almost exactly as long as broad, and Kings Mountain plants were about the same. However, there is variation in the Chapel Hill form in all points, and we found one plant here with very large fine flowers with crimped margin in which the flowers were 5.7 cm. long by 8 cm. broad or 1.4 times broader than long, as in the mountain form.

As to the leaves, our local plants have leaves that average larger and broader in proportion than the mountain ones. In herbarium specimens from Caldwell and Mitchell Counties the leaves average 3.8 x 9.1 cm. or 2.4 times longer than broad. In the Chapel Hill plants they average about 5.7-6 x 11 cm., or only 1.9 times longer than broad. On one branch of a plant with very large leaves all the leaves averaged 1.6 times longer than broad, the longest leaf being 8.4 x 14.8 cm. Leaves from collections made on our recent trip run as follows:

Crowders Mountain plant: leaves 1.8-2.1 times longer than broad.
Crowders Mountain plant: leaves 1.5-2 times longer than broad.
Kings Mountain plant: leaves 2.1-2.7 times longer than broad.
Kings Mountain plant: leaves 2.1-2.2 times longer than broad.
Kings Mountain plant: leaves 2-2.1 times longer than broad.
Kings Mountain plant: leaves 2-2.5 times longer than broad.
Kings Mountain plant: leaves 2.3-2.7 times longer than broad.
Table Rock plant: leaves 1.9-2 times longer than broad.
Table Rock plant: leaves 2-2.5 times longer than broad.

The greenish dots in the flower throats vary in the Chapel Hill plant from quite conspicuous to almost invisible. In flower color, in habit, in pubescence of pod and young parts no differences of consequence appear in the plants from different places. It would seem then that while no constant difference appears between the plants from various localities the mid-State form has flowers that average longer in proportion and leaves that average broader in proportion

PLATE 22



Reduced one-half.

and larger than the high mountain form. I therefore think it best to give the mid-State plant a form name and propose to call it.

Rhododendron catawbiense f. insularis n. forma.

Differs from the type in the larger and broader leaves and in the longer flowers. North Carolina: On precipitous bluffs by streams, lower Piedmont and Coastal Plain.

As the streams along which our form grows are not connected in any way with the territory occupied by the type, and as the respective areas are so widely separated, it is highly probable that there has been no intermixture for a good many thousand years. This territorial segregation would in itself almost justify the separation of the forms even though little or no structural distinction were obvious, and it would perhaps be justifiable to give the Kings and Crowders Mountain form a distinctive name also. It is probable that at all these widely separated stations the plants are a little different, though the differences are hard to distinguish.

In our map of distribution (Pl. 22) we have given only a few scattered locations in the high mountains, but have indicated all that we know of with certainty at altitudes of less than 2,500 feet. The species is also found on Lookout Mountain, Tennessee, and as far south as Albertville, Marshall County, Alabama (Harbison).

It may be well to add a word as to the eastward extension of *R. maximum.* It extends to about Hickory in the center and has been reported as extending into Surry and Gaston Counties on the north and south (Pinchot and Ashe, N. C. Geol. Survey Bull. **6**: 68. 1897). As Surry reaches the mountains we would expect it in abundance there, but its occurrence in Gaston seemed so improbable that I wrote Mr. Ashe for confirmation, and he replied that he thinks this record a mistake due to confusion with *R. catawbiense.* We can now report it about sixty miles farther east at Yadkin College on the Yadkin River, Davidson County. We have also found it about one mile below Buffalo Shoals Bridge on the Catawba (Statesville-Hickory road).

The species is, of course, abundant down the eastern slopes of the mountains and on the nearby hills as far as Lenoir and Hickory, while *R. catawbiense*, while scarce and scattered, continues its descent eastward to far lower altitudes.

We have also indicated on the map such stations for *R. carolinianum* and *R. minus* as we have good evidence to include. So far as *R. carolinianum* is concerned, these few stations are certainly nothing more than indications of an extensive distribution within the regions they occupy. *Rhododendron minus* is not yet well worked out and three of the stations we give (Highlands, Macon Co.; Whiteside Mountain, Macon Co.; and Hickory Nut Gap, Brunswick Co.) are on the authority of Mr. T. G. Harbison, who collected it in these places for the Biltmore Nursery. At Hickory Nut Gap he found not only the magenta, but also a white-flowered form. The fourth North Carolina station shown on the map is in Richmond County almost on the South Carolina line on Mark's Creek near its entrance into the Pee Dee river about eight miles from Kollock, S. C., on the plantation of Mr. Frank B. Pegues. It also grows just across the line in South Carolina on the same plantation. Mr. Harbison has also found the species at Stumphouse Mountain, Oconee County, S. C.

CHAPEL HILL, N. C.

DOUBLE NUMBER

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Elisha Mitchell Scientific Society

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JOURNAL OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY—Quarterly. Price $2.00 per year; single numbers, 50 cents. Most numbers of former volumes can be supplied. Direct all correspondence to the Permanent Secretary, at the University of North Carolina, Chapel Hill, N. C.

In addition to original papers on scientific subjects this Journal publishes the Proceedings of the Elisha Mitchell Scientific Society, and the Proceedings of the North Carolina Academy of Science, as well as abstracts of papers on scientific subjects published elsewhere by members of the Faculty of the University of North Carolina.

PLATE 23

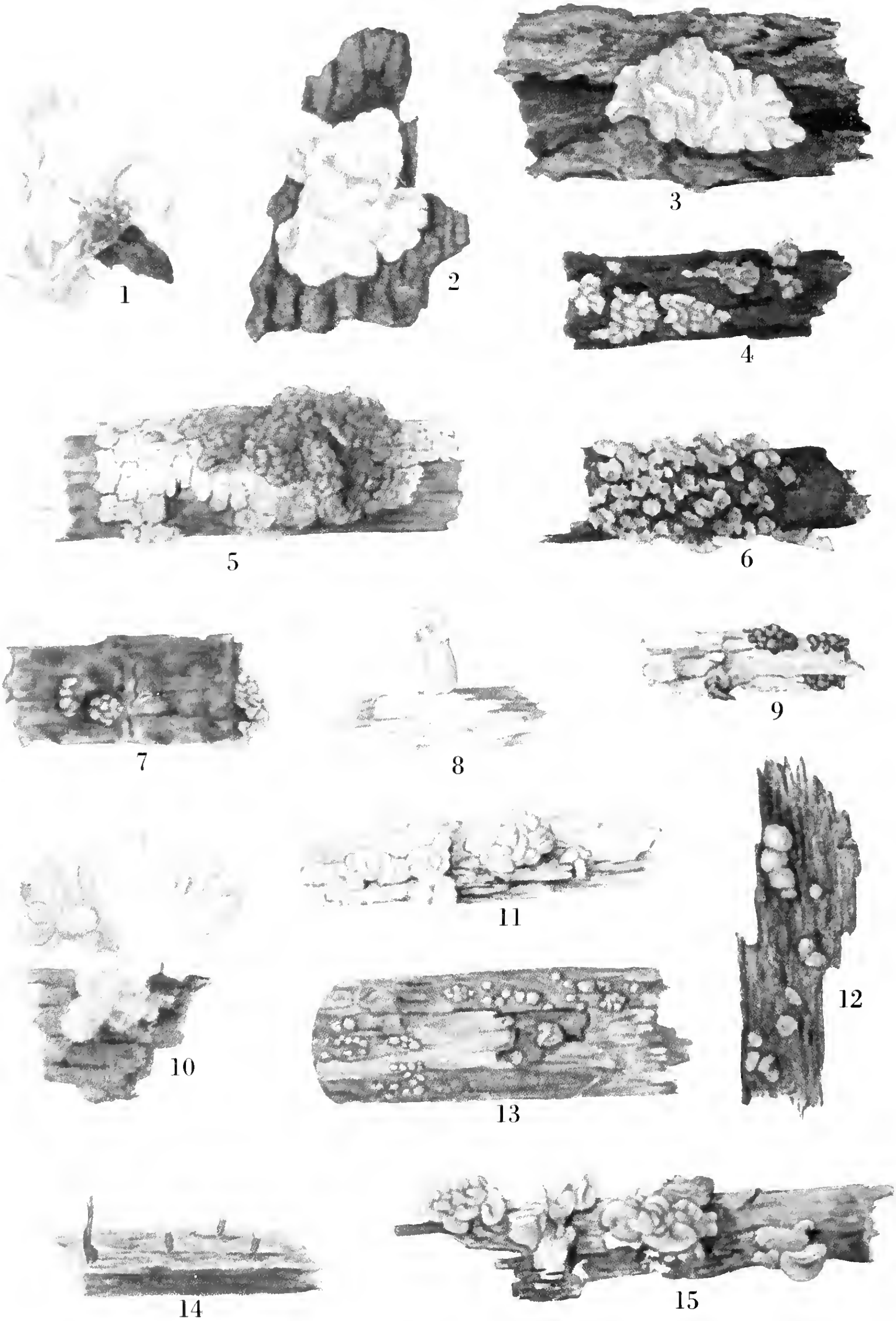

FIG. 1. NAEMATELIA QUERCINA. No. 3935. FIG. 2. TREMELLA LUTESCENS. No. 3895. FIG. 3. NAEMATELIA NUCLEATA. No. 4023. FIG. 4. NAEMATELIA NUCLEATA. No. 3961. FIG. 5. TREMELLA VIRENS. No. 4070. FIG. 6. TREMELLA CARNEOALBA. No. 3877. FIG. 7. DACRYMYCES PALLIDUS. No. 4072. FIG. 8. DACRYOMITRA DUBIA. No. 3969. FIG. 9. DACRYMYCES FUSCOMINUS. No. 4075. FIG. 10. DACRYMYCES AURANTIUS. No. 3500. FIG. 11. DACRYMYCES ELLISII. No. 4035. FIG. 12. DACRYMYCES ABIETINUS. No. 3832. FIG. 13. PLATYGLOEA CAROLINIANA. No. 4199. FIG. 14. GUEPINIA SPATHULARIA (a small form on pines). No. 3998. FIG. 15. DACRYMYCES PEDUNCULATUS. No. 4185.

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CHLORINATION BY MIXED CARBON MONOXIDE AND CHLORINE

By Francis P. Venable and D. H. Jackson

This investigation was undertaken to see if a mixture of carbon monoxide and chlorine could not be substituted for carbonyl chloride in certain chlorinations. It may be worth while to draw attention to this reaction as the use of phosgene in the industries has been suggested, but the dangers connected with its shipment and use may be prohibitive.

Chlorination with joint action of some reducing agent has been practiced for a long time. At first carbon and chlorine were used by d'Oerstedt and many others. The carbon has been replaced with carbon tetrachloride by Demarçay[1] and Cambonlives[2]; with carbon plus carbon monoxide by Ribau[3]; with sulfur by Matignon and Bourion[4]; with sulfur monochloride by Bourion[5]; and with carbonyl chloride by Chauvenet[6]. The experiments detailed below show that carbon monoxide with admixed carbon reacts readily in conjunction with chlorine, and in the references given it will be noted that both carbon tetrachloride and carbonyl chloride react when used alone. Carbonyl chloride, especially, reduces and chlorinates with ease oxides, sulphides and some very stable salts.

The experiments reported here were necessarily limited in number but may be extended at some more convenient time. The substance to be acted on was placed in a boat in a hard glass tube and the mixed

[1] *Compt. Rend.*, **104** (1887), 111.
[2] *Compt. Rend.*, **150** (1910), 175, 221
[3] *Bull. Soc. Chim.*, **39** (1883), 14.
[4] *Compt. Rend.*, **138** (1904), 631, 760
[5] *Compt. Rend.*, **145** (1907), 62.
[6] *Compt. Rend.*, **152** (1911), 87, 1250.

gases passed over it. The heating was done by an electric sleeve and the temperature up to 550° recorded by an accurate thermometer inserted in the tube with the bulb by the side of the boat. No corrections were made for the portion of the thermometer stem exposed beyond the tube, as such accuracy was not necessary. For temperatures above 550° ammeter readings, which had been standardized, were used. Two or three grams of the powdered samples were taken for each experiment.

Expt. 1. Litharge was heated quickly up to 300°, then at the rate of 5° to the minute. At about 345° it began to turn black and at 360° it had changed entirely to black. At 390° the color began to lighten and at 400° it was pure white. No further change was observed up to 550°. The white powder (lead chloride) was entirely dissolved by water. This experiment is especially instructive as the two steps in the reaction, first a reduction followed by chlorination, are quite distinct.

Expt. 2. The green oxide of uranium (U_3O_8) was treated in the same way and also showed the antecedent reduction changing at first into the black oxide (U_3O_5) at 450° and forming the chloride at 500°.

In the remaining experiments the two steps, reduction and chlorination, if they occurred separately could not be distinguished. Chromic oxide began to chlorinate at 625°, stannic oxide at 400°, alumina at 450°, manganese dioxide at 460°, calcium oxide at 630°, magnesia at 475°, ferric oxide at 460° and zirconia at 480°.

The mixture of gases used in these experiments probably contained an excess of carbon monoxide. For a few of the substances the reaction was repeated with a considerable excess of chlorine. Under these conditions the chlorination temperature for ferric oxide was lowered from 460° to 370° and for zirconia from 480° to 425°.

A comparative table of the approximate chlorination temperatures follows:

Substances	CCl_4	$CCl_4 + Cl_2$	$COCl_2$	$CO + Cl_2$	$COCl_2$ + Cln
TiO_2	430°		450°		
ZrO_2	430°	300° +	400°	480°	425°
ThO_2	420°		650°		
SnO_2	400°		400°	400°	
BaO	330°		500°		
MgO	390°		450°	475°	
ZnO	400°		450°		
Al_2O_3	390°		400°	450°	

Substances	CCl_4	$CCl_4 + Cl_2$		$CO + Cl_2$	$COCl_2 + Cln$
Fe_2O_3	245°	below 300	350°	460°	370°
Cr_2O_3	580°		600°	625°	
MnO_2	400°		450°	460°	
NiO	550°		550°		
U_3O_8	360°		450°	500°	
Ce_2O_3	350°		600°		
La_2O_3	330°		600°		

Certain facts may be stated with regard to these reactions. First, they do not seem to take place in the case of compounds of silicon and boron. In many cases an antecedent reduction is noticed, but this takes place at a much lower temperature than that at which the reducing agent is usually effective. The combination of the reducing agent with chlorine as carbon tetrachloride or carbonyl chloride increases the activity. It may be that these compounds act only after dissociation, but then it is difficult to explain the still greater activity in the presence of excess of chlorine. This increased activity may be explained on the assumption that in certain cases the reduction is a surface action which slows down or ceases unless the product is removed. The rapid removal of this by the chlorine speeds up the reaction.

Our experiments show that mixtures of carbon monoxide and chlorine, the latter preferably in excess, may be very conveniently used for bringing about industrial chlorinations.

CHAPEL HILL, N. C.

A RAPID VOLUMETRIC METHOD FOR THE DETERMINATION OF ARSENIC IN ARSENATES

By James M. Bell

The rapid and exact method of Mohr for the determination of arsenious acid depends on the reaction:

$$As_2O_3 + 2H_2O + 2I_2 \rightleftarrows As_2O_5 + 4HI$$

This reaction is reversible, going toward the right when one of the reaction products is removed as it is formed. Two methods have been proposed for the removal of hydrogen iodide, both based upon the reduction of the hydrogen-ion concentration. In the first of these methods, the solution is kept neutral or slightly alkaline by means of a large excess of sodium bicarbonate, added just previously to the titration with iodine solution. This method gives satisfactory results. The evolution of carbon dioxide may be avoided by the use of disodium phosphate instead of sodium bicarbonate, as was proposed by Washburn.[1] Advantage is here taken of the slight hydrogen-ion concentration in solution containing both disodium phosphate and monosodium phosphate. This method also gives excellent results.

A volumetric method of equal accuracy for arsenates was sought in connection with a study of the arsenates, the results of which will appear in a later paper. The volumetric method of the Association of Official Chemists[2] depends on the reversal of the reaction as written above, followed by titration with iodine solution. This is effected by treating the arsenate with rather concentrated sulphuric acid and potassium iodide and by removal of one of the constituents on the left of the equation, iodine. Long continued boiling follows until all the iodine has been volatilized. The solution is then neutralized and the arsenious oxide titrated against iodine solution in the presence of sodium bicarbonate. The removal of iodine by long continued boiling, sometimes until fumes of SO_3 are evolved requires careful watching and may also involve the removal by volatilization of arsenious iodide. A yellow deposit of this substance frequently appears around the neck of the flask and it is probable that some of it may have escaped. This loss is indicated by low results obtained with known samples and by the failure to obtain duplicate results.

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[1] Jour. Am. Chem. Soc., **30**, 31 (1908).

[2] Report of the Committee on Editing Tentative and Official Methods of Analysis (1916), p. 67.

A better method of eliminating free iodine was sought. The following procedure was finally employed: To 25 c.c. of a solution containing about 0.1 gram of As_2O_5 were added one to two grams of potassium iodide and after solution 5 c.c. of conc. hydroclorie acid. This mixture is then boiled and as free iodine appears a dilute solution of sodium sulphite is added from a burette to destroy the yellow color of the solution. Sodium thiosulphate cannot be used, as it is decomposed by hot acid solutions with the liberation of free sulphur. Boiling is continued for a few minutes after the last appearance of iodine in order to remove any excess of sulphite, as SO_2, which may have been used. The flask is then cooled in cold water and caustic soda solution is dropped in from a pipette until litmus paper turns blue. Dilute hydrochloric acid is added drop by drop until the litmus paper just turns red. Crystals of disodium phosphate, 3 to 5 grams, are now added, turning the litmus blue, and titration against N/10 iodine solution follows immediately.

As a test of the accuracy of the above method, a quantity of As_2O_3 was dissolved in dilute hydrochloric acid solution; the solution was made alkaline and then faintly acid; an excess of disodium phosphate was added and titration against iodine solution followed immediately. After this titration, the solution containing arsenic only as As_2O_5 was reduced by the method above described and the titration repeated. The results will be seen to agree within the experimental error:

	No. 1	No. 2	No. 3	No. 4
First titration	17.55cc	17.80cc	17.79cc	17.76cc
Second titration	17.58cc	17.79cc	17.76cc	17.74cc

The quantities of arsenic taken in each of the trials was not the same, so that no comparison should be made of the different samples with each other. The agreement between the two titrations for the same quantity of arsenic shows that the proposed method is as accurate as the Mohr method for arsenious oxide. The time required, after the sample is in solution, is from 15 to 20 minutes for reduction to the arsenious condition and subsequent neutralization and titration against the standard iodine solution.

CHAPEL HILL, N. C.

THE LAND OF FERNS

THE HABITATS AND DISTRIBUTION OF THE FERNWORTS OF FLORIDA

By John K. Small

Plates 24-28

Florida has been called the "land of flowers." Even more properly could it be called "the land of ferns." While its pinelands and prairies are themselves not without their own peculiar species, its woods, hammocks, marshes, swamps, and sand-dunes, so abound in fern plants, often in such remarkable luxuriance, that Florida becomes the Fern State, par excellence, among all the States of the Union.

The pinelands[1] are the forests of pine trees, apparently the permanent tree covering replacing the broad-leaved growth or hammocks of former ages, at least in some parts of the state.

The prairies[2] are flat, more or less extensive, usually damp, treeless areas, mostly in the peninsula.

The woods[3] are the broad-leaved forests, usually in the hilly or rolling parts, especially of northern Florida.

The hammocks[4] are dense growths of broad-leaved trees, in a pine-forest or on a prairie, mostly in peninsular Florida. The use of this word is confined to Florida and adjacent States. It was formerly confused with the word hummock. The word is probably of Indian origin. Lime-sinks which are usually conspicuous ferneries, are commonly in hammocks, and are included here.

The marshes[5] are wet prairies. They are common throughout the peninsula. Depressions in the prairies often form ponds.

The swamps[6] are wet woods. They are common throughout the state and are often along or near streams.

The sand-dunes[7] are undulating or hilly areas of siliceous or cal-

---

[1] Their characteristic fernwort genera are few: *Anemia, Pycnadoria, Pteris, Sphenomeris, Lycopodium, Selaginella.*

[2] Their characteristic genera are few: *Blechnum, Onoclea, Lycopodium.*

[3] Their characteristic genera are few: *Botrychium, Ophioglossum, Lygodium, Pteris, Adiantum, Asplenium, Athyrium, Dryopteris, Polystichum, Selaginella.*

[4] Their characteristic genera are numerous: *Ophioglossum, Cheiroglossa, Trichomanes, Actinostachys, Stenochlaena, Polypodium, Phlebodium, Campyloneurum, Phymatodes, Vittaria, Paltonium, Adiantum, Hypolepis, Cheilanthes, Asplenium, Tectaria, Dryopteris, Nephrolepis, Selaginella, Psilotum.*

[5] Their characteristic genera are several: *Osmunda, Ceratopteris, Acrostichum, Blechnum, Anchistea, Lorinseria, Dryopteris, Azolla, Lycopodium, Selaginella, Isoetes.*

[6] Their characteristic genera are: *Osmunda, Actinostachys, Acrostichum, Anchistea, Lorinseria, Blechnum, Dryopteris, Meniscium, Nephrolepis, Onoclea, Lycopodium, Selaginella, Psilotum.*

[7] Their characteristic genera are few: *Pteris, Cheilanthes, Selaginella.*

PLATE 24

In Timms' Hammock near Princeton, Fla. Showing the simple-leaved or nearly simple leaved halberd-fern (*Tectaria heracleifolia*) and the much compound maidenhair (*Adiantum tenerum*). Both of these species are rock-lovers and are here growing on a perpendicular face of oolitic limestone.

careous sand, active along the coast, stationary back of the coastal lagoons and in the interior. Sheli-mounds or kitchen-middens are usually built on or near dunes. The so-called "scrub," which comprises extensive areas of white sand supporting a characteristic plant association, is included here.

In these various areas are found about one-third of the different kinds of ferns and fern-allies growing naturally in all America north of Mexico; and the variety in habit and leaf-form of these far exceeds that exhibited by the ferns of any other part of either the United States or Canada. In Florida more than one hundred ferns and fern-allies, both simple and complex, from very small to gigantic, grow either as native or as naturalized plants.

There are ferns in nearly every part of the State, but only the more marked areas of distribution will be referred to on the following pages, to-wit: northern Florida is the long horizontal (east-west) axis of the State, while peninsular Florida is the long perpendicular (north-south) axis. The Florida Keys[8] are the islands of the Florida reef off the southern coast. The Everglade Keys are islands in the southern part of the Everglades. The Florida Keys and Everglade Keys are islands of rock. The upper series of Florida Keys are of coral limestone and are clothed with hammock. The Everglade Keys and the lower series of Florida Keys are of öolitic limestone and are clothed with both hammock and pine forest. The lime-sink region is an area in the northwestern part of the peninsula, which is surrounded by other phytogeographic regions. It comprises mostly rolling sandy pine woods with depressions or sinks, but only few streams. However, near the rivers there are many large springs.

The different kinds of fernworts may be grouped thus: (a) naturalized exotic species, (b) endemic species, (c) species typically of a more northern distribution, and (d) species typically of more southern distribution, and consequently tropical.

There are, apparently, only three naturalized fernworts. These are:

Pycnadoria longifolia (Bracken)
Dryopteris setigera (Wood-fern)
Marsilea vestita (Pepperwort)

[8] Key (Spanish cayo, English cay) primarily applied to islands along the coast in and near Spanish speaking countries, largely replaces the use of the word "island," particularly in southern Florida, and by the inhabitants is applied to islands in the Everglades as well as to the islands of the coast and reef of Florida.

Little is known concerning a rare bracken, *Pycnadoria longifolia*, within our range, and it may yet prove to be a native plant. There seems to be no good reason why it should not be native, for it occurs plentifully on the islands on the other side of the Gulf Stream. The other exotic has found such favorable habitats and grows in such a natural manner that it is difficult to realize that it is not a native plant. In fact, never has a satisfactory explanation been offered as to how the large wood-fern, *Dryopteris setigera*, did gain a foothold in these apparently natural habitats. Of course, it may be that its spores were primarily carried there by winds from cultivated plants and thus lodged in favorable habitats. But the true manner of its introduction may remain a mystery forever. The pepperwort, *Marsilea vestita*, is native west of the Mississippi River. It seems to have been brought into Florida through the agency of the railroads, and as far as we know it has not been found far away from the lines of traffic.

Two additional species, a bracken, *Pycnadoria cretica*, and a clubmoss, *Lycopodium cernuum*, are sometimes considered naturalized plants, but there has never been good evidence advanced to support that theory.

There are seven endemic species in Florida. These are:

Asplenium biscayneanum (Spleenwort)
Asplenium Curtissii
Tectara Amesiana (Halberd-fern)
Selaginella funiformis (Resurrection-plant)
Selaginella humifusa
Isoetes Chapmanii (Quillwort)
Isoetes alata

The first-mentioned spleenwort grows in only one hammock—a hammock on the Everglade Keys, in the southern end of the Everglades, while the second one is found in hammocks in the lime-sink region of the northern part of the peninsula. The *Tectaria* is known only in the hammocks of the Everglade Keys. The first-cited species of *Selaginella* occurs in peninsular Florida, while the second one has been found in northern Florida, as well as in the peninsula. The first-mentioned quillwort has been found only in western Florida, while the second one is known to occur only in the Gulf Hammock region. This region is a rather narrow strip along the upper western coast of the peninsula with limestone near the surface or cropping out. The coast line differs from that farther south in being devoid of

PLATE 25

On Robert's Island, Everglades, west of Little River Prairie. The most abundant fern in this photograph is the Boston fern (*Nephrolepis exaltata*). It is accompanied by the Swamp-bracken (*Blechnum serrulatum*) which may be distinguished by the leaves with the longer and separated leaflets. The Swamp-bracken is rarely epiphytic, but the Boston-fern commonly inhabits both palms and deciduous leaved trees.

islands. The very gradually sloping ocean bottom acts as a barrier against the approach of high waves from the Gulf of Mexico. The long-leaf pine is the most abundant tree, but there are many low hammocks besides the great Gulf Hammock of Levy County—whence the name for the region.

The vast majority of the species comprising this fern flora are native plants that occur also outside the state, either in the eastern United States or in tropical America. They fall into two groups: the one composed of northern elements, the other of southern elements. With very few exceptions the plants are fibrous-rooted. The species of the genera *Botrychium*, *Ophioglossum*, and *Cheiroglossa* are fleshy-rooted and doubtless all represent mycorrhiza forms.

The northern elements comprise about one-third of the species. They are not, however, all strictly typical of decidedly northern latitudes. On the one hand, some only extend northward as far as southern Georgia, and others are merely in the coastal plain of the Gulf of Mexico, while on the other hand a few of the species that are naturally included among the northern ferns are found in the American tropics. Following is a list of the species:

Botrychium obliquum (Grape-fern)
Botrychium virginianum (Rattlesnake-fern)
Ophioglossum vulgare (Adder's-tongue)
Ophioglossum crotalophoroides
Trichomanes Boschianum (Filmy-fern)
Osmunda regalis (Royal-fern)
Osmunda cinnamomea (Cinnamon-fern)
Lygodium palmatum (Climbing-fern)
Pteris aquilina (Brake)
Adiantum Capillus-Veneris (Venus'-hair fern)
Pellaea atropurpurea (Cliff-brake)
Anchistea virginica (Chain-fern)
Lorinceria areolata (Chain-fern)
Asplenium platyneuron (Spleenwort)
Asplenium resiliens
Athyrium Filix-foemina (Lady-fern)
Dryopteris Thelypteris (Shield-fern)
Dryopteris floridana (Wood-fern)
Dryopteris hexagonoptera (Beech-fern)
Polystichum acrostichoides (Christmas-fern)
Onoclea sensibilis (Sensitive-fern)
Marsilea vestita (Pepperwort)
Azolla caroliniana (Watermoss)
Lycopodium alopecuroides (Clubmoss)

Lycopodium prostratum
Lycopodium adpressum
Lycopodium carolinianum
Selaginella apus (Little-clubmoss)
Selaginella ludoviciana
Selaginella acanthonota (Resurrection-plant)
Selaginella arenicola
Isoetes flaccida (Quillwort)

These ferns occupy, for the most part, temperate and sub-tropical Florida.[9] The plants are predominantly terrestial. Some kinds, however, are aquatics; others are amphibious. Many kinds prefer as a habitat what we commonly call soil, others grow best on exposed rock, while a few seem to thrive luxuriantly in "peat."

The lowland kinds reach Florida along the Atlantic Coastal Plain, while the highland species extend southward from the mountains or from the Piedmont region along the hills and ridges and through the river-valleys of western Georgia and eastern Alabama. The typically lowland kinds, the majority of the species of the above list, often range far southward in the peninsula, while the ranges of the highland species generally end in northern Florida or in the upper part of the peninsula, for example: *Athyrium Filix-foemina, Dryopteris hexagonoptera, Polystichum acrostichoides.*

The tropical elements, comprising, as they do, about two-thirds of the species, furnish the more varied and consequently the more interesting fern-plants of our range. They are represented by:

Ophioglossum tenerum (Adder's-tongue)
Cheiroglossa palmata (Hand-fern)
Trichomanes lineolatum (Filmy-fern)
Trichomanes punctatum
Trichomanes Kraussii
Actinostachys Germani (Curly-grass)
Anemia adiantifolia (Flowering-fern)
Ceratopteris pteridoides (Floating-fern)
Ceratopteris deltoidea
Stenochlaena Kunzeana (Holly-fern)
Acrostichum aureum (Leather-fern)
Acrostichum excelsum
Polypodium Plumula (Polypody)
Polypodium pectinatum
Polypodium polypodiodes (Resurrection-fern)

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[9] Includes particularly all the state, except the Everglade Keys, the Cape Sable region, and the Florida Reef. The ferns have been considered in "Ferns of Tropical Florida," i-ix, 1-80, 1918, and "Ferns of Royal Palm Hammock," i-vii, 1-38, 1918, and incidentally in papers published in the journal of The New York Botanical Garden from 1904 to 1920.

PLATE 26

In a fern grotto with walls of limestone, near Pineola. Four kinds of ferns may be seen: three spleenworts and one halberd fern (*Tectaria heracleifolia*). The lace-like spleenwort at the top of the print is *Asplenium Curtissii*, one of the endemic species. The narrow-leaved spleenwort is *Asplenium heterochroum*, while the lanceolate-leaved one at the bottom of the cliff is *Asplenium verecundum*.

Phlebodium aureum (Serpent-fern)
Campyloneurum angustifolium (Strap-fern)
Campyloneurum costatum
Campyloneurum latum
Campyloneurum Phyllitidis
Phymatodes exiguum (Vine-fern)
Vittaria lineata (Shoestring-fern)
Paltonium lanceolatum (Tip-fern)
Pycnadoria pinetorum (Bracken)
Pteris caudata (Brake)
Adiantum tenerum (Maidenhair-fern)
Adiantum melanoleucum
Hypolepis repens (Beaded-fern)
Cheilanthes microphylla (Lip-fern)
Blechnum serrulatum (Swamp-bracken)
Blechnum occidentale
Asplenium serratum (Spleenwort)
Asplenium heterochroum
Asplenium abscissum
Asplenium dentatum
Asplenium erosum
Asplenium verecundum
Asplenium Curtissii
Asplenium cristatum
Tectaria heracleifolia (Halberd-fern)
Tectaria coriandrifolia
Tectaria minima
Tectaria Amesiana
Meniscium reticulatum (Everglade wood-fern)
Meniscium serratum
Dryopteris panamensis (Shield-fern)
Dryopteris stipularis
Dryopteris normalis
Dryopteris augescens
Dryopteris ampla
Dryopteris gonglyodes
Dryopteris parasitica
Dryopteris radicans
Dryopteris tetragona
Nephrolepis exaltata (Boston-fern)[1]
Nephrolepis biserrata (Sword-fern)[1]
Sphenomeris clavata
Lycopodium cernuum (Clubmoss)
Psilotum nudum (Brushmoss)

These tropical ferns, nearly all of which are hammock plants and

[1] These common names are used interchangeably.

grow for the most part on trees, in humus, or on exposed limestone, are largely confined to three well-defined areas. Two of these constitute "tropical Florida"—that is to say, the Florida Keys and the Everglade Keys. The other area is that lime-sink region in the northwestern part of the peninsula, mentioned above and to be referred to more fully further on.

The Florida Keys consist of a chain of low islands built upon the Florida Reef mainly south of the peninsula. All of them are remnants of what were evidently larger islands in past ages.[10] They are really situated in the waters of the Gulf Stream, and extend from the Atlantic Ocean on the northeast into the Gulf of Mexico on the southwest. They are naturally divided into two groups: those of the upper or more northern group, which are of coral-rock, and those of the lower or more southern group, which are of limestone. All the islands are clothed with tropical hammock, except portions of a few and here they are either partly heath-like or partly covered with pine. These hammocks and pinelands harbor but ten different kinds of native ferns. But of these, one only (*Paltonium lanceolatum*) has not yet been discovered on the Florida mainland.

The Upper Keys are for the most part long and narrow ridges of coral-rock and are clothed with evergreen hardwood forests which harbor the one kind of fern not yet known to occur on the Everglade Keys. The Lower Keys are more spread out, more even, and rather less elevated above the sea. They are clothed both with hardwood forests and, in the case of a half-dozen islands, with pine woods, at least in part. The Lower Keys have as yet yielded no ferns not already known on the Everglade Keys. In fact, the Florida Keys have a much smaller fern flora than the Everglade Keys. Only about one-fifth of the species of the Everglade Keys have been found there. No doubt in their past the fern flora was larger than it is now. It may have rivaled or excelled that of the Everglade Keys, for the Florida Keys consist of two areas of different ages, coral and limestone; but this region has been for a long time decidedly on the wane as regards area, and doubtless also vegetation.

In addition to the leaching process of erosion that has reduced the surface of the Everglade Keys, the Florida Keys have had the mechanical and chemical action of the sea to contend with and the evi-

[10] This statement refers to the islands composed of rock. The mud flats and islands covered with mangrove are evidently, as a rule, increasing in size, especially in sheltered places, but they scarcely figure in the matter of ferns. They are destitute of ferns, unless an occasional *Acrostichum aureum* got a foothold there.

In a fern grotto near Pineola (referred to on page 102). Here is where fourteen kinds of ferns grow copiously and intimately intermixed. Some thrive on rich humus, others on bare rock. Notice the plant of the needle-palm (*Rhaphidophyllum hystrix*) on the top of a boulder. The nearest relatives of this palm are in eastern Asia.

dence of reduction are not hard to observe. These islands have been worn down and washed away not only by the never-ceasing action of the sea, but also by the hurricanes of ages. This is quite evident. The rock surface, particularly in the case of the Lower Keys whose limestone corresponds to that of the Everglade Keys, is polished off and plate-like, instead of merely leached out and honeycombed. What the former fernworts consisted of we cannot even imagine, but we are safe in assuming that the list was more extensive than that which we are able to record there now.

The Everglade Keys, the second tropical area—a phytogeographic region isolated in the Everglades—comprise a curved series of limestone islands appearing on the surface about the neighborhood of the Miami River, trending southwest and disappearing in the southern end of the Everglades. The area is surrounded by the Everglades, except where a portion fronts on Bay Biscayne or its lagoons.

As on the Florida Keys, the native flora of the Everglade Keys consists almost wholly of tropical plants. Pineland predominates in extent of area today; but the few hammocks—evidently themselves remnants of a once dominant and magnificent forest—still harbor nearly fifty kinds of our tropical ferns. And among these are no naturalized exotic species, no typically northern species. The only northern ferns in the vicinity are those occurring where the Everglades and the limestone islands meet.

The number of ferns and fern-allies in this region is quite remarkable when we consider that the area involved comprises only a few hundred square miles, a mere fraction of the State's large area. Although variety in soil and other physical features is slight, this area harbors more than fifty per cent. of the fern flora of Florida.

An overwhelming majority of the species are typically tropical American. In addition to these, there are several cosmopolitan species and a few endemic ferns. The plants of nearly one-third of the species are epiphytic, living on the moisture of the air and getting solid food from the bark and small quantities of humus, while anchored on trees and prostrate logs. This condition doubtless makes up to some extent for the lack of variety in topography, climate, and soil.

The Everglade Keys consist of two main divisions, the Biscayne pineland[11] and the Long Key pineland. The former group is made

[11] These two groups of islands are separated from each other by a distance of three miles. The intervening Everglades contain a number of sloughs which represent the upper reaches of an unmapped river that flows southward and empties into the Bay of Florida. The larger or eastern group of islands takes its name from Bay Biscayne which washes the shores of one of the islands for a distance of about fifteen miles. The smaller group takes its name from Long Key, the largest island lying west of the sloughs referred to above.

up of about a dozen larger islands, which are mostly bounded by the Everglades on two sides and separated from each other by narrow channel-like intersecting prairies. The Long Key group has a much smaller area than the Biscayne pineland. It consists of about five larger islands and a few smaller ones. Both groups are of limestone, and they are slightly elevated above the Everglades. The rock is rather porous and the softer spots of the almost universally exposed surface have been eroded, mostly by leaching out, so as to form a surface honeycombed with all sizes of cavities having very ragged and sharp edges. These limestone islands are almost completely forested with the Caribean-pine (*Pinus caribaea*) which grows nearly everywhere on the exposed rock. However, the pine-woods, or pinelands, are interrupted here and there by hammocks or areas of hardwood shrubs and trees, some areas small and some much larger, although all taken together these comprise but a very small percentage of the region under consideration. The hammocks may be divided into two groups; first, the high pineland hammocks which are islands or colonies of hardwood trees in the pine-woods. They are dry except for the water contained in deep lime-sinks and in the humid air. They number about a score. Second, are the low pineland hammocks, indefinite in number and situated along the boundary line of the pinelands and the Everglades proper and prairies. These are usually high and dry towards the pine-woods and low and wet along the Everglades or prairies.

The ratio of pineland ferns to hammock ferns seems astonishingly small. There are only three kinds of ferns that may be considered naturally pineland plants. Even two of these ferns will spring up in clearings in hammocks which have been partly destroyed either by nature or by man. The other forty-eight species are hammock plants. Their habit ranges from the stiffest to the most graceful and their structure from the coarsest to the most delicate. The pineland species are strictly terrestrial in habit. The hammock kinds are to a great extent epiphytic.

The hammocks of the Biscayne pineland are rich repositories of ferns. The trees are nearly all evergreen. More abundant are: pigeon-plum (*Coccolobis*), devil's claws (*Pisonia*), blolly (*Torrubia*), cherry (*Laurocerasus*), wild-tamarind (*Lysiloma*), Jamaica-dogwood (*Ichthyomethia*), coral-bean (*Erythrina*), torch-wood (*Amyris*), bitterwood (*Simarouba*), gumbo-limbo (*Elaphrium*), Guiana-plum

On Hammer Key, midway between Cape Sable and Royal Palm Hammock. The plant here illustrated is a close second to whatever species might be considered the oddest fern in Florida. The plants are here shown in the dry weather state. The leaflets are rolled up in such a way as to give the pendant leaves, which vary from one to three feet in length, the aspect of strings of beads. This plant is a form of the tropical polypody, *Polypodium plumula*.

(*Drypetes*), soapberry (*Sapindus*), butter-bough (*Exothea*), wild-coffee (*Colubrina*), lancewood (*Ocotea*), stopper (*Eugenia*), and many others, all growing closely associated to make the hammocks.

Nearly all the kinds of ferns of tropical Florida may be found in them. The well-like lime-sinks, the hammock floor, and the trunks and limbs of rough-barked trees are the habitats of the many species, each and all usually forming ferneries of indescribable beauty. They can be appreciated by the eye alone; even the camera falls far short of doing them justice. In some places the deep well-like sinks have their sides completely covered with mats of iridescent filmy-ferns (*Trichomanes*) to the exclusion of all other vegetation, while nearby tree-trunks and logs are completely covered with another kind of filmy-fern. In other sinks the small halberd-fern (*Tectaria*) predominates, while in still others we find the honeycombed rock sides adorned with various ferns, filmies (*Trichomanes*), maidenhair (*Adiantum*), halberd-fern (*Tectaria*), wood-fern (*Dryopteris*), and spleenwort (*Asplenium*), not to mention the rarer holly-fern (*Stenochlaena*), which is one of the few climbing ferns of Florida. The hammock floor is another kind of fernery. There the strap-fern, various wood-ferns, maidenhair, spleenworts, sword-fern, and large halberd-fern, comprise the more conspicuous kinds. One species of wood-fern (*Dryopteris ampla*) is, at the same time, the most conspicuous and most elegant. It sometimes has an erect stem a foot and a half high and elegant lace-like leaves with a spread of a dozen feet! In these remarkable hammocks there are ferns everywhere, ferns underground, ferns on the ground, and ferns in the air. The trunks and limbs of rough-barked trees are actually clothed with masses of ferns, as well as with orchids, and other plants. The resurrection-fern (*Polypodium*), the strap-fern (*Campyloneurum*), and the Boston-fern (*Nephrolepsis*) are the most common epiphytic kinds, while the elegant vine-fern (*Phymatodes*) occurs plentifully in one hammock. Palmetto trees are often conspicuous ferneries. Below the crown of leaves and growing from among the old leaf-bases one often finds a collection of Boston-fern (*Nephrolepis*), shoestring-fern (*Vittaria*), hand-fern (*Cheiroglossa*), and serpent-fern (*Phlebodium*).

In passing, before taking up the additional tropical locality, it may be of interest to mention a kind of half-way station where a few tropical kinds of ferns have found congenial conditions, and flourish. It is the magnificent hammock that clothes the eastern shores of Lake

Okeechobee. Here vegetation is protected by the tempering of the westerly winds, that blow across the lake in winter. As a consequence the Boston-fern (*Nephrolepis*) and the strap-fern (*Campyloneurum*), as well as some epiphytic orchids, are abundant.

The third tropical fern area—and the one by far most difficult to understand or to interpret satisfactorily—is that district several hundred miles north of the Everglade Keys previously referred to, the lime-sink region in the northwestern part of the peninsula. Here the hammock is composed of trees not tropical, but characteristic of more northern warm temperate regions. The trees are mostly deciduous-leaved. There one finds iron-wood (*Carpinus*), oak (*Quercus*), elm (*Ulmus*), sugarberry (*Celtis*), mulberry (*Morus*), sweet-gum (*Liquidambar*), ash-leaved maple (*Negundo*), maple (*Acer*), and flowering dogwood (*Cynoxylon*). The boulders, sinks, chasms, cañons, caves, and cliffs hidden in these hammocks support a growth of ferns, even if of a fewer number and of less variety, yet, just as tropical, both in character and in kind, as do the lime-sinks of the Everglade Keys. There is one striking difference, it is true. This is the absence of the epiphytic kinds so common to the more southern area. The resurrection-fern (*Polypodium polypodioides*) is the only truly epiphytic kind. Following is a list of the species found in the largest known grotto:

Polypodium polypodioides (Resurrection-fern)
Polypodium Plumula (Polypody)
Polypodium pectinatum
Pteris cretica (Bracken)
Adiantum tenerum (Maindenhair-fern)
Asplenium abscissum (Spleenwort)
Asplenium Curtissii
Asplenium heterochroum
Asplenium platyneuron
Asplenium verecundum
Tectaria heracleifolia (Halberd-fern)
Dryopteris floridana (Wood-fern)
Dryopteris normalis (Shield-fern)
Dryopteris reptans

These species, or the related types in the case of the endemic *Asplenium Curtissii*, are of general tropical distribution. The plants are evergreen and have no apparent resting period during the year.

Such a copious growth of ferns is rarely seen anywhere else in Florida. Boulders and cliffs are often entirely hidden from view by dense masses of the various ferns growing intimately mixed. On other over-

hanging rocks with rather smooth faces the plants are often scattered. Most of the kinds grow not only on the perpendicular faces of the rocks, but also on the top of boulders and all more or less horizontal surfaces. The masses of leaves of all sizes and kinds of ferns often completely hide numerous pitfalls of various sizes and ranging from a few feet to twelve feet deep. Walking is rendered exceedingly dangerous from these treacherous pitfalls alone, not to mention the soft and crumbling edges of cliffs and ledges.[12]

Among the tropical ferns that do not comply with our rule of these three tropical phytogeographic areas, are the amphibious leather-ferns (*Acrostichum*), which extend northward along the coastal strip or through the Everglades up into the Lake region, the floating-ferns (*Ceratopteris*) which are scattered through the peninsula up into the Lake region, and such epiphytes as the hand-fern (*Cheiroglossa*), the serpent-fern (*Phlebodium*), the vine-fern (*Phymatodes*), the shoe-string fern (*Vittaria*), two species of strap-fern (*Campyloneurum*), and the sword-fern (*Nephrolepis*).

The exception in the case of the epiphytes, however, is easily accounted for. The soil or rock conditions in the country lying between southern Florida and the northern part of the peninsula are wanting, but whenever the conditions of hammocks in this intervening territory are favorable, for example, the hammock on the eastern shore of Okeechobee, these epiphytes, finding congenial conditions, take hold and thrive.

There are nine kinds of ferns common to the Everglade Keys and to the lime-sink region. They are of tropical origin. There are forty-two species growing on the Everglade Keys not yet found in the lime-sink region, and five species have been collected in the lime-sink region not yet met with on the Everglade Keys.

Travelers and botanists observed and perhaps collected specimens of ferns in Florida before the beginning of the Eighteenth century. Then during the earlier part of the last century, further collections were made in many localities, and about the middle of that century nearly fifty species of ferns were known to grow wild in the entire state. During the eighth and ninth decades of the last century and

[12] For more detailed accounts of these fern grottoes see A. H. Curtiss, Plant World 5: 68-70, 1902, and R. M. Harper, American Fern Journal 6: 68-81, 1916

the first decade of the present century, however, during which periods collectors carried on botanical explorations in the less-known parts of the state, the list of Florida ferns was increased by more than fifty additional species. So that now, as already stated, we know that in this state alone there are growing, without cultivation, over one hundred different kinds of ferns and fern-allies.

THE NEW YORK BOTANICAL GARDEN.

THE REGIONAL GEOGRAPHY OF SOUTH CAROLINA ILLUSTRATED BY CENSUS STATISTICS

By Roland M. Harper

Plate 29

In the *Journal of School Geography* (afterwards called the *Journal of Geography*) for January and March, 1898, there is a 14-page description of South Carolina by Prof. L. C. Glenn—a former resident of that state, and a North Carolinian by birth—which is a good example of what can be done by a careful observer with the proper geographical point of view, without reference to census reports or other previous literature.

The present paper supplements Prof. Glenn's by dividing the same state into natural regions and illustrating some of the contrasts between them by means of statistics, mostly taken from the 13th United States Census (1910). The main object of this study is to give readers an idea of the vast amount of geographical information that is buried in census reports and going to waste, as it were, for lack of geographers sufficiently interested in that kind of work to dig it out and put it together by regions. Most of the same kinds of ratios here worked out are indeed given in recent census reports for whole states, but as the average state is divisible into at least half a dozen regions, differing in all sorts of ways, the contrasts between them are pretty effectually concealed by the common practice of using state averages.

Description is here reduced to a minimum, to avoid unnecessary duplication of what has already been written by Professor Glenn and others. And in order to economize space only a few of the many possible kinds of statistics are used, but those few are believed to be among the most significant. By utilizing more of the census tables, and also by going back to earlier censuses, the length of this article could have been increased many times without sacrificing much of its geographical interest. Statistics could also have been obtained from other sources than census reports; for example, the relative areas of different soil texture classes from government soil surveys, and the relative abundance of different trees or other plants from the writer's field notes. But these lines have not yet been worked up with a degree of thoroughness at all comparable with a census, and they may therefore be left out of consideration at present.

Conditions in South Carolina are very favorable for showing certain fundamental relations between geology, or soil, and civilization. The state can be divided into seven or eight belts approximately parallel to the coast, each differing from its neighbors in geology, soil or topography (and incidentally in climate, though that gives no abrupt transitions and therefore does not help us much in drawing the regional boundaries), with corresponding differences in the density, racial composition and education of the population, the development of agriculture, etc. The counties, although rather large for statistical refinements (averaging about 709 square miles each in 1910) fit these belts very well, considering the fact that they were laid out with little regard to regional geography. This is not quite so true of census periods previous to the last, however, when some of the counties were larger, and that is one reason why the regional statistics given here are based on the last census only. (A few additional counties have been created since 1910, but those are of course ignored.)

The different belts or regions were well described by Maj. Harry Hammond, of Aiken County (1829-1916), one of the greatest geographers the South ever produced, in the 6th volume of the Tenth Census, and in still greater detail in his 734-page handbook of South Carolina, published about the same time (1883) by the state agricultural department.* The present writer, having visited most of the counties in South Carolina, has introduced some minor modifications, and the boundaries as now recognized are shown on the accompanying sketch map.[2]

The regions will be described very briefly, and the results of the statistical investigations then presented in a table, followed by appropriate comments.

The *Blue Ridge*, including the highest mountains in the state, with a maximum altitude of about 3,500 feet, occupies only a few hundred square miles in the extreme northwest, too small an area to figure at all in the statistical tables. It is therefore combined with the next region.

The *upper Piedmont region*, on account of its geographical position, is the highest, coolest, and most hilly part of the state, with the ex-

* Unfortunately the only leaf bearing the author's name, namely, that containing the preface and bibliography, was cut out of most copies of this monumental work by the publishers, on account of a slight misunderstanding; and the authorship is therefore sometimes credited to the then Commissioner of Agriculture by those who do not know the circumstances.

[2] The fall-line, or boundary between the Piedmont and sand-hills, is generalized from a geological map by Earle Sloan, in the 1907 Handbook of South Carolina.

ception of the Blue Ridge just mentioned. Its area is about 3,600 square miles. It is characterized by gneiss and other metamorphic rocks, which weather into red clayey loams and gray sandy loams of medium fertility. It has more water-power in proportion to its area than any of the regions lower down, and cotton manufacturing is a very important industry. The statistics used are based on the six northwesternmost counties, all of which have more whites than negroes (which cannot be said of any other six contiguous counties in the state).

The *lower Piedmont region* is similar geologically to the upper, except for having more granite, trap and slate. On account of being nearer the coast and less elevated the topography is a little smoother and there is less water-power than in the upper division (as could be brought out by means of certain census statistics if one wanted to take the trouble). The soil is apparently just a little more fertile on the average than that nearer the mountains. (Fertile soil and abundant water-power hardly ever characterize one and the same region.*) The area is about 6,500 square miles, approximately coextensive with eleven counties.

The boundary between the upper and lower Piedmont regions is a rather arbitrary one, for the most striking difference between them, and one not wholly accounted for by the rather small differences in natural environment, is in the racial composition of the population, which is brought out in the table. The cause of this marked difference is not altogether clear, but it is probably largely historical, though it may be partly fortuitous. The same distinction can be made very satisfactorily in the Piedmont region of Georgia, but not in North Carolina, perhaps on account of soil differences.

The innermost division of the coastal plain is the *sand-hills*, which extend all the way across the state,—except for being interrupted by river valleys—and a considerable distance into the two adjoining states. The area is irregular and not easy to measure, but is probably about 3,000 square miles. This is an elevated and very sandy region, as the name implies. It has an agreeable climate and pure water, and contains some well-known winter and spring resorts, such as Camden and Aiken. The soil is rather poor, but the counties used in preparing the table (Chesterfield, Kershaw and Lexington) all include parts of more fertile regions, so that the census statistics are not altogether

* See Journal of Forestry (Washington) 16: 113, 1918.

typical. If it were possible to exclude the more fertile areas the figures would show greater contrast than they do.

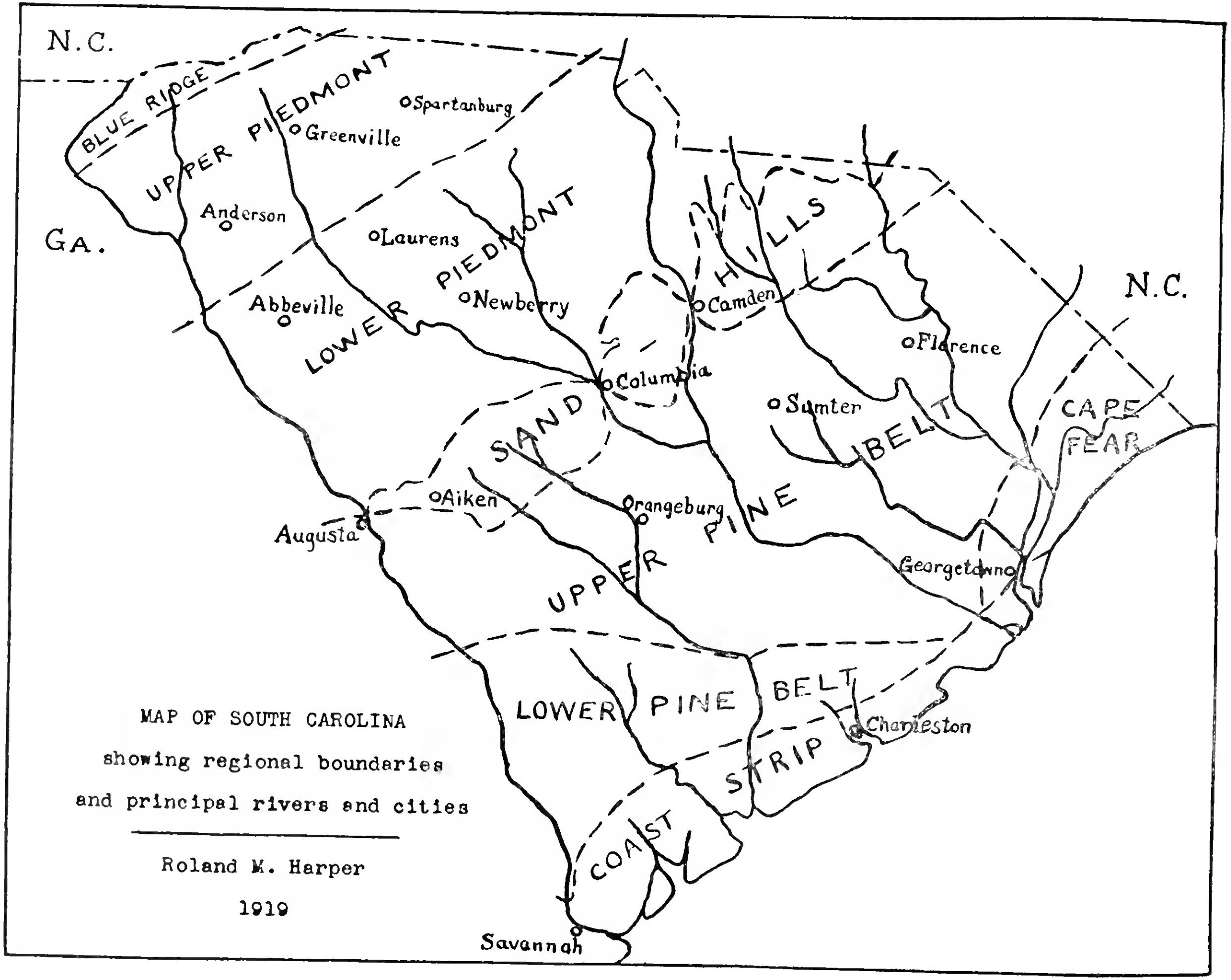
The *upper pine belt* embraces considerable diversity, from high red hills to flat sandy pine woods and swamps, but there are all sorts of intermediate conditions, and it would be difficult to subdivide this region in any way that would give us significant statistics as long as the counties are as large as they are. The region covers about 14 counties and 11,000 square miles.

The *lower pine belt* differs from the preceding chiefly in having almost no red hills, more ponds, more sandy soil, and more long-leaf pine. It is approximately coextensive with Dorchester, Colleton and Hampton counties, and covers about 2,700 square miles.

The *Cape Fear pine-barren region* centers around Wilmington, N. C., and in South Carolina includes most of Horry County, about half of Georgetown (but not half its population), and perhaps part of Marion, or about 1,500 square miles. It is characterized by copious summer rain (nearly half the annual preciptation comes in the four warmest months), and the soils are sandy and pretty well leached of fertility. The statistics used to illustrate it are based on Horry County alone.

The *coast strip* includes the islands, marshes, and marly flats along the coast, mostly south of the Santee River. The soils are of various degrees of fertility, but mostly pretty well supplied with phosphorus, the raw rock or ore of which has been mined in several places for fertilizing purposes. Some of the richest soil is too swampy for profitable cultivation, however, especially since the competition of Louisiana practically put an end to the rice industry that once flourished here. The area is about 1,600 square miles of land, and the counties of Charleston and Beaufort are taken as typical.

The first table gives statistics of density, race, nativity and illiteracy of the population in each of seven regions, together with corresponding figures for the state as a whole at the last four censuses, this addition being for the purpose of illustrating certain general principles better and facilitating comparisons with other states that have been or will be studied in the same way. There is also a column for urban percentage, urban population being defined at the last two censuses as that living in cities and towns with over 2,500 inhabitants. (Previously a higher minimum was used, so that in order to get comparable figures one has to pick out the places having more than the



MAP OF SOUTH CAROLINA
showing regional boundaries
and principal rivers and cities

Roland M. Harper
1919

specified number of inhabitants and add them together.) The illiteracy percentages are based on the number of persons over ten years old unable to read and write.

In both tables the highest numbers in each column are printed in heavy type and the lowest in italics, to help the reader pick out the extreme range of variation in South Carolina and also the salient features of each region as far as they are shown by the kinds of data here used.

The influence of racial demography is illustrated still further by putting at the bottom of both tables separate statistics for the twenty counties that have more than 40% of whites, and the 23 "blackest," with less than 40% white.

TABLE 1. POPULATION AND ILLITERACY

REGIONS, ETC.	Inhabitants per Square Mile	Percentage of total				Percent illiterate			
		Native White	Foreign White	Negro	Urban	Native White	Foreign White	Negro	Aggregate
Whole state, 1880	33.0	38.6	0.7	60.7	7.7	22.4	4.9	78.5	55.4
1890	38.2	39.8	0.5	59.7	10.5	18.1	6.3	64.1	44.9
1900	44.4	41.2	0.4	58.4	12.8	13.6	6.5	52.8	35.9
1910	49.7	44.4	0.4	55.2	14.8	10.3	6.8	38.7	25.7
Upper Piedmont	**78.1**	68.3	0.3	31.4	16.8	13.3	10.0	36.0	*20.3*
Lower Piedmont	53.6	39.6	0.2	60.2	11.7	7.6	7.8	39.6	26.4
Sand-hills	36.4	53.5	*0.1*	45.3	7.5	11.5	3.5	44.5	26.2
Upper pine belt	45.2	34.2	0.2	65.6	7.3	10.3	4.1	37.5	27.6
Lower pine belt	26.9	36.9	0.1	63.0	0	8.1	*0.1*	**49.8**	**34.3**
Cape Fear region	*22.5*	**75.1**	0.1	*24.7*	*0*	**18.7**	**16.0**	41.1	21.6
Coast Strip	74.0	*28.3*	**2.4**	**69.2**	**49.5**	*2.0*	6.1	*35.9*	25.2
20 whitest counties	57.0	56.7	0.3	42.9	15.6	12.3	7.6	37.1	22.8
23 blackest counties	43.8	31.9	0.5	67.6	14.0	6.8	6.3	39.7	28.7

The second table is devoted to agriculture, and gives for the whole state in 1900 and 1910, for each region, and for the same two groups of counties above outlined, the ratio of "improved land in farms" to total area (expressed as a percentage), the expenditure for fertilizers in the year preceding, per acre of improved land in the census year (in dollars and cents), the percentage of white farmers, the average num-

ber of improved acres managed by white and negro farmers, and the value of farm buildings, for both races separately and combined.

TABLE 2. AGRICULTURE

REGIONS, ETC.	Percentage of area improved	Fertilizer per acre	Percent of white farmers	Improved acres per farm		Value of buildings per farm		
				White	Negro	White	Negro	Aggregate
Whole state, 1900	29.6	0.78	45.0	50.1	26.6	304	67	173
1910	31.2	2.49	45.1	43.9	26.8	617	155	364
Upper Piedmont	**41.1**	1.77	68.0	31.9	26.9	536	**183**	**422**
Lower Piedmont	41.0	*1.63*	39.4	46.0	**31.0**	680	157	363
Sand-hills	25.6	2.36	62.0	38.7	27.0	453	126	337
Upper pine belt	32.9	**3.75**	36.8	52.1	26.8	726	156	365
Lower pine belt	20.2	1.94	42.4	58.5	21.8	570	141	324
Cape Fear pine-barrens	*11.9*	2.96	**81.7**	*26.7*	13.8	*271*	*104*	243
Coast strip	15.0	2.78	*8.1*	**100.0**	*12.4*	**1083**	122	*200*
20 whitest counties	33.8	2.45	58.0	37.1	28.4	556	169	393
23 blackest counties	29.2	2.62	32.8	55.4	25.8	720	146	335

The densest population is in the upper Piedmont region, where the most manufacturing is, but the coast strip is a close second, on account of containing the state's principal seaport, which includes nearly half the population of that strip. The other extreme is in the Cape Fear region, which has the poorest soil. The last named has the largest percentage of whites; while the coast strip has the most negroes and also the most foreigners, for more or less obvious reasons. The percentage of negroes and foreigners in the state as a whole has decreased in recent decades.

The aggregate illiteracy is least in the two regions that have the smallest proportion of negroes, and would probably be greatest in the coast strip but for the fact that nearly half the population of that region is urban and therefore has pretty good school facilities. Illiteracy among the native whites, curiously enough, is greatest where negroes are fewest, and vice versa, as may be seen not only from the highest and lowest figures in that column, but also from the statistics of the two divisions of the Piedmont, which, as already stated, are similar in natural features but differ widely in racial composition, and from the two groups of counties with different proportions of negroes.

If illiteracy is a safe criterion, the quality of the foreign-born population of South Carolina has deteriorated a little in recent decades, while the natives, both white and black, have made great progress. The foreigners are still a little superior to the native whites in that respect, however, except in the coast strip, where they are most numerous. (In the other regions they have probably never constituted as much as 1% of the population since there has been a census.) Nearly half the negroes in the lower pine belt were unable to read and write at the time of the last census, perhaps because that region had less than ten white people per square mile; not enough to maintain a very efficient system of rural schools. There is much less variation in illiteracy among the negroes in different regions than among the whites, which agrees very well with what we already know about that race.

Turning now to the agricultural statistics, the percentage of improved land depends largely on soil fertility, and is lowest in the poorest region, but in South Carolina some moderately fertile regions, like the coast strip, have large areas of swamp and marsh, which materially restricts the possible improved acreage. This may explain why the lower Piedmont region has a trifle less improved land than the upper, instead of more, as we might expect from the smoother topography, etc.

The expenditure for fertilizers depends partly on soil fertility or the lack of it, and partly on the intensity of cultivation, being nearly always high near cities. In South Carolina, however, the upper pine belt leads in this respect, though it has neither the poorest soil nor the largest urban population; and the explanation may be simply that the farmers there (and also in the corresponding part of North Carolina) have acquired the fertilizer habit. A farmer in Marlboro County established a world's record for corn in 1889 by raising 255 bushels on one acre, of course with the aid of heavy applications of fertilizers. It will be noticed that the expenditure for fertilizer per acre in the state more than trebled between 1900 and 1910. This may be partly due to a progressive exhaustion of the natural fertility of the soil, and the decline in value of money (amounting to about 40% in that decade) following the discovery of gold in the Klondike region in 1897, certainly had something to do with the increased expenditure, but after making allowance for these a growth of the practice of using commercial fertilizers is still apparent.

The percentage of whites among the farmers does not differ much from that among the total population, except that it is decidedly larger in the poorest region and smaller in the coast strip; in the latter case perhaps because of the scarcity of good water in the rural districts, a condition which negroes can endure better than whites.

White farmers have the smallest farms and poorest buildings in the Cape Fear region, where white illiteracy is most prevalent, and the other extreme in all three particulars is the coast strip, long characterized by large plantations of rice, sea-island cotton, and other crops not grown much in the interior. There the average white farmer cultivates over eight times as much land as the negro, and has a home worth nearly nine times as much. As already noted under the head of illiteracy, the negroes vary less in different regions than the whites. They seem to prosper most in the Piedmont region and least in the two regions along the coast; but that does not necessarily indicate that the coast negroes are not the most contented.

Looking at the last two lines of the table it will be noticed that the cultivated acreage and building values of white farmers increase with the proportion of negroes, just as the illiteracy for the same race decreases, which is contrary to the opinion held in some quarters that the presence of an inferior race in large numbers tends to lower the civilization standards of the superior race.

In the state as a whole the farms of white men decreased in size between 1900 and 1910 (following a pretty general tendency throughout the country, correlated with increasing population and increasing agricultural efficiency), while those of negroes increased a little. The average white farmer's buildings doubled in money value during the same period, while the negro's increased nearly 2½ times. Part of this increase of value is only apparent, as explained under the head of fertilizers a few paragraphs back, but after making allowance for that substantial improvement is evident. Just how long this had been in progress is not certainly known, for the census made no returns of farm-building values prior to 1900, nor did it separate the races of farmers until then.

The relations between soil, population, race, education, improved land, farm areas, building values, etc., pointed out here, are not peculiar to South Carolina by any means, but have been found to apply in much the same way in Georgia, Alabama, and other southeastern states, a fact which should be of considerable interest to geographers.

FLORIDA GEOLOGICAL SURVEY.

NOTES ON THE LOWER BASIDIOMYCETES OF NORTH CAROLINA *

By W. C. Coker

Plates 23 and 30-66

With the exception of some minute forms parasitic on insects, etc., the true fungi may be divided into three great classes, as follows:

A. Phycomycetes. Simple plants of webby or moldy growth, not forming large or complicated fruit bodies. In their reproduction they are distinguished by the presence, in most cases, of true eggs or gametes in addition to asexual spores. They include, among other forms, some of the molds, such as the black mold on bread, the downy mildews, which are destructive parasites on higher plants, as grapes, potatoes, etc., and the water molds, one of which causes a disease of fish. None of this group will be treated in this work. A separate book on the water molds of the United States will be published soon.

B. Basidiomycetes. To this group belong the vast majority of mushrooms and toadstools. With the exception of some of the lower groups, such as the rusts and smuts, which are diseases of higher plants and are not treated in this book, they form in nearly all cases a complicated fruit body that we usually speak of as the plant, but this body is the product of an extensive vegetative system of a webby or cottony character which ramifies through the earth or wood from which the mushroom arises. The most distinctive character is the production of the spores on the ends of club-shaped or pear-shaped microscopic branches or basidia which are formed on certain parts of the fruit body, and help to make up a distinct spore-producing surface or layer called the hymenium. In most species each basidium produces four spores on its end, each supported on a slender stalk.

C. Ascomycetes. A very extensive group of fungi of great economic importance because of the large number of destructive parasites it contains. They are quite varied in form and size, ranging from minute (as in many parasites, in yeast, etc.) to moderately large (as in the Morels). The spores are contained in sacs which

* Many of the drawings in this chapter were made by Miss Alma Holland, Assistant in Botany. Mr. J. N. Couch, Assistant in Botany, drew most of the figures of Gymnosporangium, Septobasidium and Sebacina. A good many figures were drawn by the author and inked in by Miss Holland. The colored plate was painted in part by Miss M. E. Eaton, of New York, and in part by Miss Cornelia S. Love, of Chapel Hill.

are usually elongated and which discharge by the rupture of the tip. There are usually eight spores in each sac, but this number is in some cases increased by the division of the original ones into several or many before they are discharged. Only a few of the larger forms will be treated in this series of papers, and the key to their families will be given later.

KEY TO THE FAMILIES OF BASIDIOMYCETES

1. HYMENOMYCETES: Hymenium (spore bearing surface) exposed before maturity and composed of gills, tubes or spines, or in some cases quite smooth. In those mushrooms which are enclosed in a cup when young the cup is broken and the plant emerges before the spores are ripe.)

Basidia elongated and divided into four or fewer cells by cross walls; texture of plant toughly or softly gelatinous or waxy in the species here treated (of the very large group of rusts we are treating only a few species of Gymnosporangium, which are gelatinous at one stage).

Basidia arising from a specialized, thick-walled, constricted spore, which is two-celled in the species here treated (the other families of rusts are here omitted)..*Aecidiaceae* (p. 115)

Basidia not arising as above, but from hyphal threads, or in Saccoblastia from thin-walled, lateral, pendat sacs ....*Auriculariaceae* (p. 119)

Basidia divided across into several irregular cells; texture of plant fibrous and leathery ....*Septobasidium* (in *Auriculariaceae*) (p. 125)

Basidia ovate, pyriform or spherical, divided into two or four cells by longitudinal or oblique walls

Basidia arranged in rows of several; texture gelatinous ....*Sirobasidium* (p. 128)

Basidia single; texture in one group gelatinous and forming erumpent, folded or convoluted masses; in another forming thin, resupinate, tough, leathery and coriaceous crusts; in one gelatinous genus with the form and teeth of a Hydnum... *Tremellaceae* (p. 129)

Basidia long, slender, terete, forked above into two long branches, not divided into cells; texture gelatinous or sub-cartilaginous........... *Dacrymycetaceae* (p. 160)

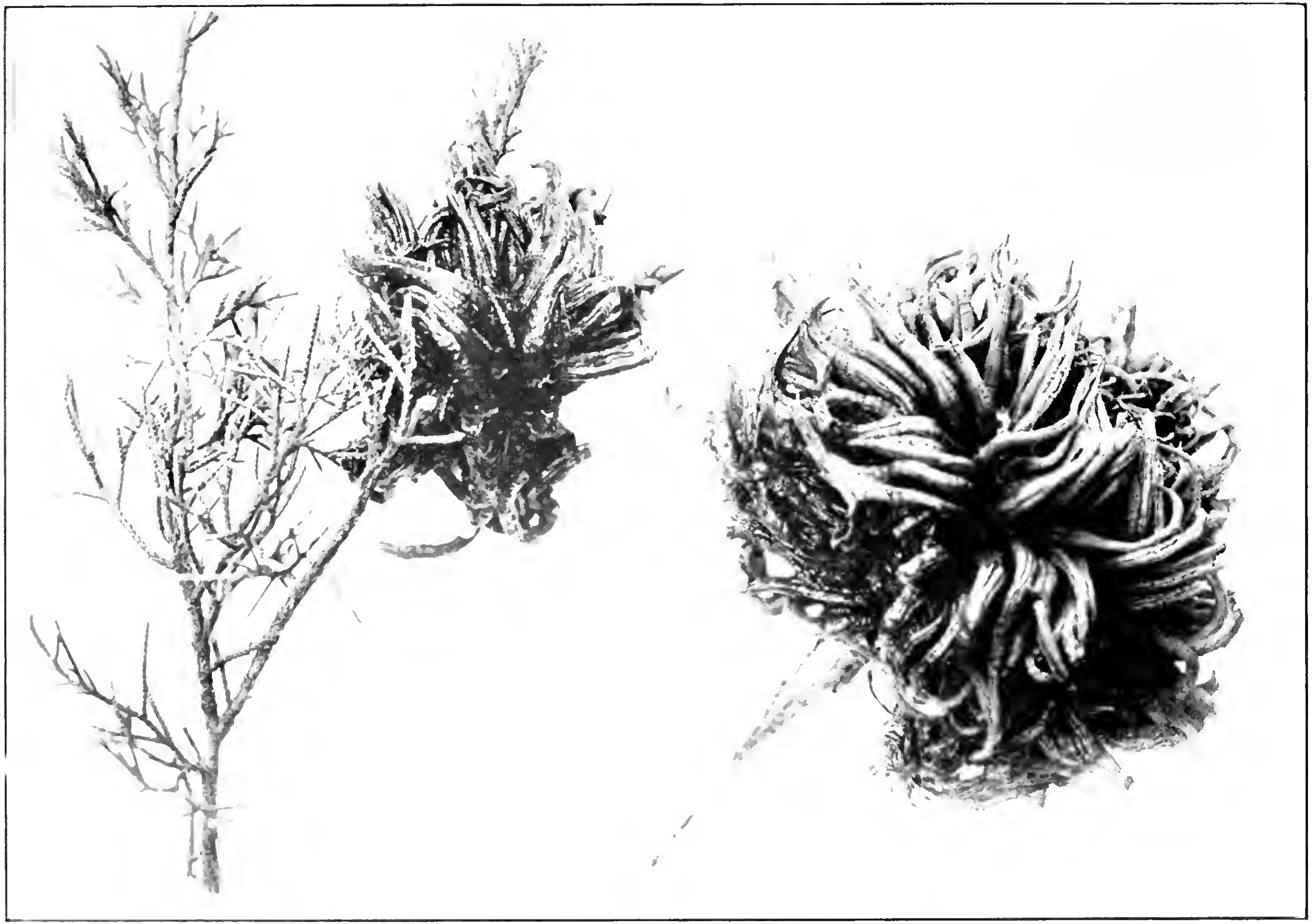
Basidia not divided into cells and not forked, mostly club-shaped

Hymenium smooth; form of plant various, but without sharp distinction between an expanded cap and a stem, sometimes completely spread out (resupinate) on the substratum.

Texture tough, leathery and fibrous; if branched, the branches not rounded (except in a few species)....*Thelephoraceae*

Texture softer, fleshy; plant cylindrical or club-shaped and un-

PLATE 30



GYMNOSPORANGIUM JUNIPERI-VIRGINIANAE. No. 2307a.

branched or more often branched like a coral or bush or tree............*Clavariaceae*
Texture fleshy; plant mushroom-shaped or trumpet-shaped; hymenium borne on the under side and often slightly wrinkled............*Craterellus*[*]

Hymenium borne on pendant teeth (if gelatinous see Tremellodon) ....*Hydnaceae*
Hymenium borne in pores, or if gill-like (Lentinus) then the plant is very tough, dry and corky................................*Polyporaceae*
Hymenium borne on gills; plant more or less soft and fleshy..................................*Agaricaceae*

2. GASTEROMYCETES: Hymenium enclosed until maturity inside the plant body and not breaking out at all (as in the puff balls) or exposed at maturity by being elevated on a stalk (as in the phalloids); in one family forming a nest-like cup containing "eggs" at maturity.
Plant body more or less spherical or pear-shaped, sometimes stalked, opening at one or more places or wearing away to expose the spore mass ....*Lycoperdaceae*
Plant body breaking from an egg-like case at maturity and forming a delicate, more or less porous stem, which bears at its tip a smooth or folded or complicated or divided structure which supports the slimy and bad-smelling hymenium ....*Phallaceae*
Plant body small, forming a sessile or stalked cup which opens at maturity to expose a group of egg-like bodies within ....*Nidulariaceae*

AECIDIACEAE

In the most recent monograph of the true rusts or Uredinales by Arthur (N. Am. Flora 7:83. 1907) the order is divided into three families, the Coleosporiaceae, the Uredinaceae and the Aecidiaceae. Of these the last family is by far the most important economically and contains some of the most serious diseases of fruits and farm crops. The number of species is so large and the life history so complicated by a number of spore forms and an alternation of two generations, often on different hosts, that a study of the rusts is now almost a subject in itself. This complexity, together with their economic importance, has resulted in the production of a very large literature to which one may be guided by any of the recent text books on Plant Diseases, such as Duggar's *Fungus Diseases of Plants* and Stevens' *Fungi which Cause Plant Diseases.*

The destructive rusts of grains, grasses and clovers cause a loss of millions of dollars in the United States yearly. To them are closely

[*] Treated in the Agaricaceae. See this Journal **35**: 31. 1919.

related the rusts of apples, quinces, haws, etc., that cause much damage in the South Atlantic states and which infest the red cedar as their alternative host. We have chosen three species of these cedar rusts to represent the group of rusts in this paper. They belong to the genus Gymnosporangium in the family Aecidiaceae.

GYMNOSPORANGIUM

Producing on cedar in wet weather in the spring conspicuous masses of yellowish jelly either directly on the twigs, branches, or main trunks or on special large galls on the small twigs. This jelly contains a large number of two-celled spores, called teleutospores or teliospores, which sprout at once in the jelly to form elongated basidia, called promycelia, which are divided into four cells by cross walls, each cell sprouting to form a smaller curved spore called a sporidium. These last are then blown about and falling on leaves or fruits of apples or their relatives may infect them and produce in a few months discolored yellowish spots which produce on the underside tubular projections in which are borne in chains another kind of spore called the aecidiospore or aeciospore composed of one cell with a warted wall. These when blown back to the young cedar will infect the leaves and cause the development of the large galls again which are full grown and produce spores the second spring after the infection. The life history of these rusts thus requires two distinct hosts and each must be infected by spores borne on the other. On the upper side of the infected spots on the apple, etc., are borne in sunken flasks very small pycniospores which have no known function. Of the many species of the genus we select three that are found in Chapel Hill.

In addition to the treatment in North American Flora and in the texts mentioned, where references are given, one may refer to detailed work by Heald on the life history of the apple-cedar rust in the 22d Rep., Nebraska Agr. Exp. Station, p. 105, 1909; also a paper by Coons in the same series 25th Rep., p. 217, 1912.

KEY TO THE THREE SPECIES TREATED

All forming gelatinous excrescences on cedar (*J. virginiana*) in spring.
 Forming globular, uneven balls which vary in size from a pea to a small apple, from which long gelatinous processes arise..*G. Juniperi-virginianae* (1)
 Forming rough and usually thickened areas on twigs

PLATE 31

GYMNOSPORANGIUM NIDUS-AVIS No. 2772*a* (right). Much reduced.
GYMNOSPORANGIUM GERMINALE (left). Reduced.

and branches, or less often on trunks, from scars on which arise globular or wedge-shaped, often confluent and irregularly-diffused masses of jelly

Jelly masses, only up to 7 mm. high, small and rounded; teliospores, 17-23μ thick............................*G. germinale* (2)

Jelly masses wedge-shaped, up to 25 mm. high; teliospores, 13-18.5μ thick....................................*G. Nidus-avis* (3)

1. Gymnosporangium Juniperi-virginianae Schw.

G. macropus Link

PLATES 30 AND 52

This species is easily recognized on cedar by the large brown balls with shallow pits which form long, tentacle-like, gelatinous processes in wet weather in spring. After forming a crop of spores the balls die and turn blackish. The mycelium is not perennial but grows on the cedar through about twenty-one months from the infection of a leaf in July and August to spore formation a year from the following April. Infected apple leaves show thickened spots that are yellow or orange and on these spots below are several clusters of pale tubes which soon become lacerated and torn and more open. From these drop the brownish aeciospores which again infect the cedars. The elongated teliospores are 11-17 x 34-70μ and sprout from near the septum.

The abundance of the cedar in this section makes the infection of apples very easy and, with the exception of San Jose scale, which is much more easily controlled by spraying, this is the most serious apple disease in Chapel Hill. There is hardly a cedar tree in town without these rust balls on them and apple trees near them frequently lose nearly all their leaves in June and July and grow a new set by August. Different kinds of apples show great variation in resistance to the disease, the most immune apparently being the Staymans Winesap. Shockley and Bonum are very susceptible.

2307*a*. On *Juniperus virginiana*, May 7, 1915.

2. Gymnosporangium germinale (Schw.) Kern

G. clavipes Cooke and Pk.

PLATES 31 AND 52

Attacking cedar twigs about 3-8 mm. in thickness, producing a gradual fusiform enlargement about 5-12 mm. thick. The gelatinous

processes are in the form of low, small, rounded cushions crowded all around the infected area and are in large part fused into a continuous mass. Teliospores thicker than in our other species, 17-23 x 40-55μ, the upper cell with a single apical pore, the lower with a pore by the pedicel through which the germ-tube may emerge or it may emerge through the pedicel scar itself. The pedicel is stout, slightly swollen a little below the spore, 7-11μ thick at point of attachment.

The aecial stage is on the shad-bush (Amelanchier), affecting the fruits as much or more than the leaves. The infected fruits reach nearly full size and turn reddish where not attacked, but are distorted and imperfect. A tree in the garden at Glen Burnie is infected every year.

2786*a*. On twigs and small branches of cedar, April 9, 1918. Photo.

3. **Gymnosporangium Nidus-avis** Thaxter.

PLATES 31 AND 52

This is not uncommon in Chapel Hill, making rough and unsightly areas and scars on the branches and rarely even on the trunks of cedar. The gelatinous outgrowths are crowded in longitudinal rows often all around the branches for a distance at times of several feet. The branch is not much swollen, but the rough surface due to the ruptured bark makes such places larger. The individual scars are usually oval and about 2-4 x 4-7 mm., approximated by the scars of the preceding years. Gelatinous processes (telia) wedge-shaped, chestnut brown, 7-15 mm. high.

Teliospores (of No. 2772a) two-celled, 13-18.5 x 37-58μ, the two cells often partly separated before sprouting, the upper sprouting apically or at the septum or from both places, the lower from near the septum in one or two places, the slender pedicels not swollen.

This plant does not agree well with *Gymnosporangium Nidus-avis* as described in North Am. Flora (l.c. p. 196), which is said to have larger teliospores with stouter pedicels, the upper cell sprouting apically, the lower at the septum (called "apically" also). But Dr. Kern writes me that he would call our plant *G. Nidus-avis*. He says: "As regards the pores in the teliospores of Gymnosporangium the arrangement is quite variable. The generic description in the North American Flora states that they are usually 2 in each cell, but sometimes 1, 3, or 4, variously arranged, often near the septa, sometimes

apical in the upper, rarely near the pedicel in the lower. After further observations I believe that I have tried to be too definite regarding pore arrangement in the case of some of the species. In *G. Nidus-avis* it certainly is true that often only 1 pore is observed in each cell, apical in the upper, and near the septum in the lower (which is referred to as apical being as near the apex as possible) but frequently there are two pores in each cell, one apical and one near the septum in the upper, and both near the septum in the lower. The telia are often wedge-shaped instead of pulvinate. *G. Nidus-avis* is an unusually variable species and the description in the North American Flora does not provide for the variations as it should."

Our peculiar form of the species was collected by Arthur at Asheville, N. C., and cultures made on apple from his collection produced the typical aecia and pycnia. Infections made March 22nd gave pycnia by April 6th and aecia by April 27th (Mycologia 2:230. 1910).

186*a*. On branches of *J. virginiana* which were 3-4 mm. thick, March 31, 1914.

2772*a*. On branches of *J. virginiana* which were about 0.6-1-3 cm. thick, March 17, 1918.

AURICULARIACEAE

Basidia (in the more typical members of this family) elongated, divided into four or fewer cells by cross walls, each cell sprouting by a slender or a thickish sterigma to form a single spore; form of fruit body various, its texture varying from toughly or softly gelatinous to waxy. Resembling the rusts closely in the basidia and spores, but differing from them in the absence of a thick-walled, abstricted teliospore from which the basidia sprout, and in not being parasitic, but saprophytic on dead wood.

Nearest this family apparently, but doubtfully belonging to it, is the peculiar genus Septobasidium which is parasitic on scale insects and has a fibrous, leathery texture. The basidia are divided by cross walls but are variable in the form and number of the cells, and the number of the cells that produce spores is not known in all cases. We are including it here. See Brefeld l. c., p. 69.

KEY TO OUR GENERA

Texture gelatinous or waxy.

Toughly gelatinous; form more or less resembling an ear, which projects from the wood by a lateral attachment (*compare Exidia gelatinosa*); basidia not arising from a specialized sac .... *Auricularia*

Texture waxy, form crustaceous and resupinate on the wood; basidia arising from a pear-shaped, hanging sac ....*Saccoblastia*
Texture waxy; basidia not arising from a sac ....*Platygloea*
Texture dry and leathery ....*Septobasidium*

AURICULARIA

Plants sessile on dead wood by a narrow or broad base, crowded and often shelving, more or less cup-shaped; firmly gelatinous and tremelloid when wet, becoming hard when dry; spore-bearing surface rugosely channelled and pitted to resemble an ear. The basidia are long rods with cross partitions dividing them into cells, and from each cell arises a long sterigma bearing a single spore on its end. Spores white, smooth, sausage-shaped. We have but one species.

Auricularia auricula-judae (L.) Berk.

PLATES 32 AND 53

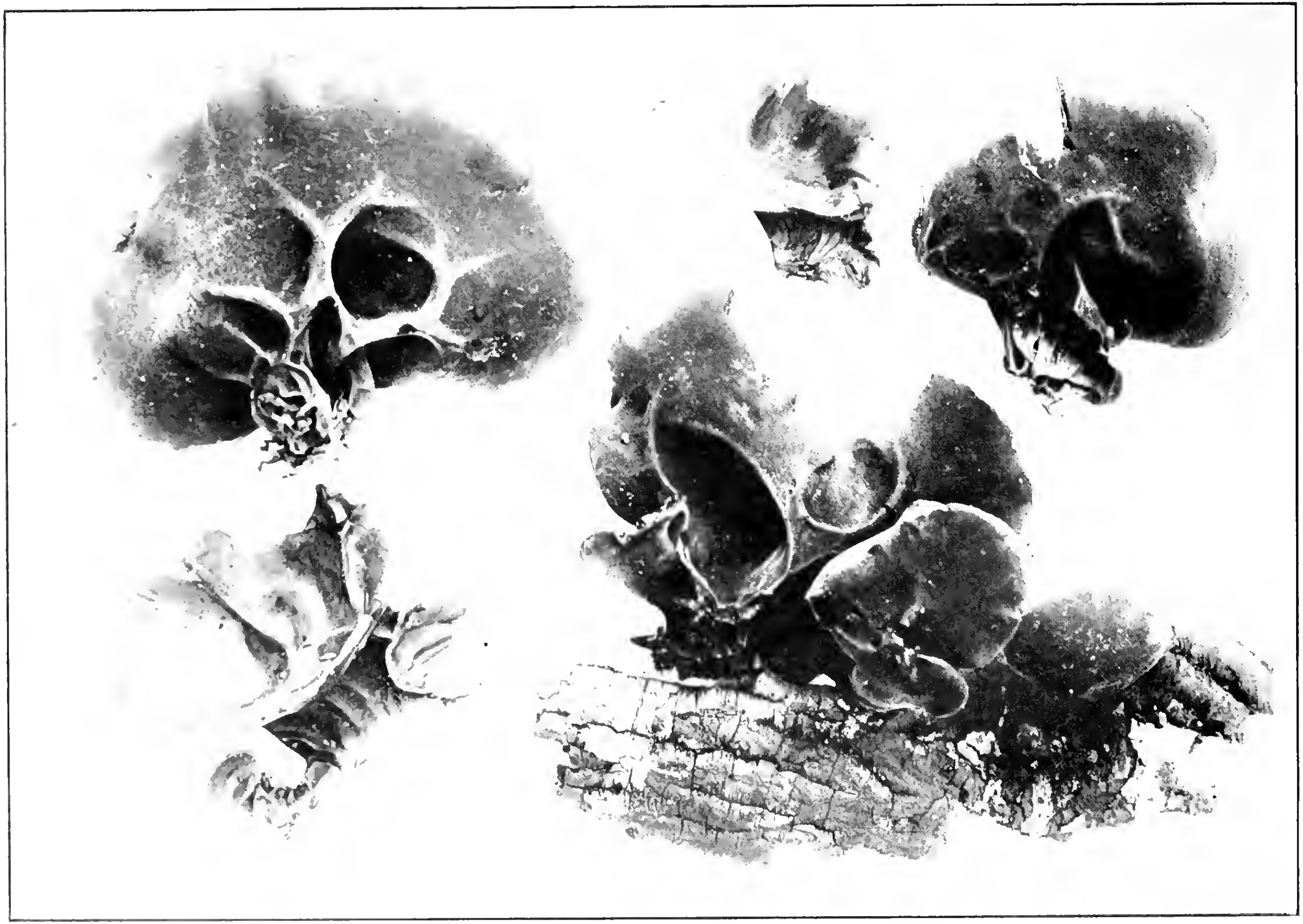
Plants sessile on dead wood by a narrow or broad base, up to 8 cm. in diameter, crowded and often shelving, more or less ear-shaped or cup-shaped, firmly gelatinous, tremelloid and translucent when damp and fresh, becoming hard when dry, a light yellowish-brown color much like that of rubber gloves. The under surface bearing the spores is more or less rugosely channelled and pitted like the inside of an ear, hence the name Jew's Ear. The dorsal surface is densely velvety tomentose with short, simple, crooked hairs.

Basidia long, slender, with cross partitions dividing them into four cells, each cell producing a long sterigma bearing a single spore on its end. Spores (of No. 3129) white, smooth, sausage-shaped, 4.3-5.4 x 10.8-14μ.

Not rare on fallen branches of deciduous trees. Edible. In China this or a closely related species is an important article of food. For illustration see Gilbert in Trans. Wis. Acad. **16**: Pl. 82, fig. 1, 1910.

1074. On a dead oak branch on ground close to Battle's Branch, May 7, 1912.
1075. On a dead oak twig east of Prof. H. H. Williams', October 18, 1911. These were small plants, not over 1.5 cm. broad.
2494. On fallen hickory by Morgan's Creek, 100 yards above Scott's Hole, May 8, 1917. Photo.
3129. On fallen oak tree southwest of athletic field, April 29, 1918.
3835. On fallen oak branch in woods east of cemetery, December 7, 1919. Spores pure white, smooth, bent, 4.8-6.3 x 11-13.7μ.

PLATE 32



AURICULARIA AURICULA-JUDAE. No. 2191.

SACCOBLASTIA

Encrusting as a thin or thickish, uneven layer of a buttery, subgelatinous texture; basidia long, divided into four cells by cross walls and bearing four spores as in the rusts, connected below with a large, pear-shaped sac which furnishes the protoplasm for the basidium. Only a few species have been described, two from southern Brazil (Möller, l. c.) and one from Poland (Bresadola: Ann. Myc. 1:112. 1903). Our species is the first from North America. This genus reminds one strongly of the rusts, particularly the genus Gymnosporangium, where the teleutospore sprouts as soon as formed. If the relationship is as close as it seems the pear-shaped sac would be the homologue of the teleutospore. Note that this sac when long is constricted in the middle.

Saccoblastia ovispora Möller var. **caroliniana** n. var.

PLATES 33 AND 53

Forming an extensive, crumpled, convoluted cushion of irregular thickness (about 5-12 mm.), the surface quite uneven and nodulated by lumps and folds; color a dull, pallid straw to pallid white, with here and there darker stains absorbed from the rotten wood; upper surface rather dull, the lower more shining; texture about that of a soft wax, subgelatinous.

Basidia arising in a very peculiar way from the extension of a thread above a lateral, pear-shaped, hanging sac; the true basidium is very much like that of a rust and is divided into four cells by cross walls, each cell giving off a short sterigma at right angles, into which the contents is poured to form a kidney-shaped spore; between the basidium and the sac is a more slender stalk of varying length which is attached to the basidium at an angle or crimp. All or most of the contents of the sac and the stalk pass into the basidium and finally into the spores. Just below the attachment of the sac the whole apparatus is cut off by a wall from the hypha that bore it and below this wall is often formed one or more lateral branches which extend and soon produce another sac and basidium. Sacs 8.5-16 x 25-45μ, the longer ones often constricted; basidiospores subelliptic, flattened or a little concave on one side, smooth, white 7-7.7 x 15-17μ. These spores sprout soon in water to form smaller secondary spores or sporidia of the same shape which are usually about 4.8 x 12μ and borne on longer sterigmata up to 18μ long or more.

Of the two species described by Möller *S. ovispora* agrees best, but differs in the very thin context and the shorter spores and smaller sacs (basidiospores 7-8 x 13μ, sacs up to 8 x 30μ). The crimp or knee where the basidium joins the stalk is also not mentioned by Möller or shown in his figures.

Our plant also is not white but a pale, dull yellowish. These differences are hardly important enough to require the establishment of a new species and I am calling our plant a variety. Drying takes place quite slowly, resulting in a thin, dark membrane which looks like dried cartilage. When placed in water again it revives perfectly to the original form, even the sacs appearing quite normal under the microscope.

Our finding this South Braziiian genus here is remarkable and wholly unexpected. It was brought in by Mr. J. N. Couch, Instructor in Botany, and adds a genus to our North American flora.

4078. In hollow oak tree near Meeting of the Waters, February 4, 1920. The plant formed an almost continuous layer over several square feet of the hollow. Photo. Type.

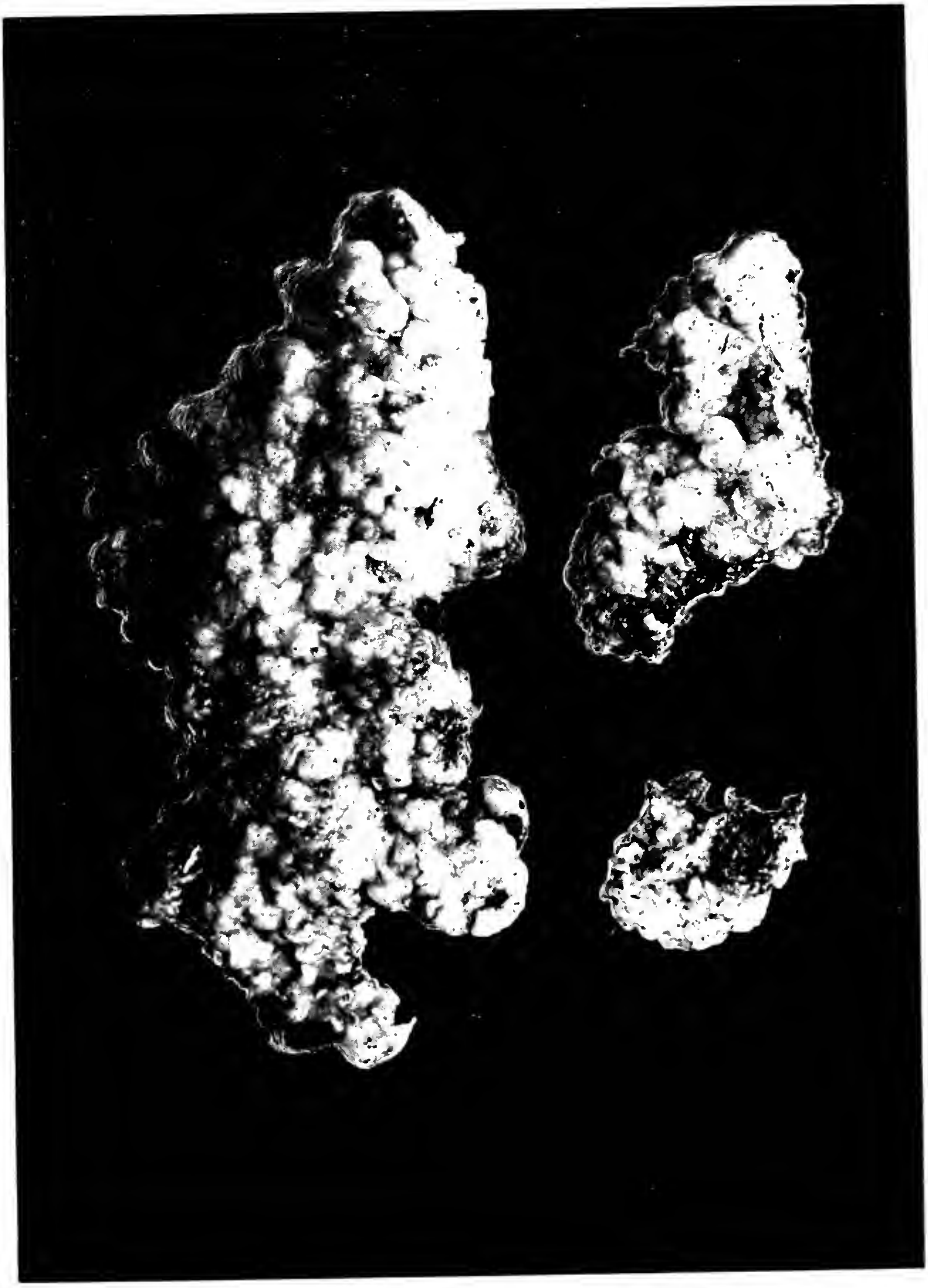
PLATYGLOEA

We take the following from the original definition of the genus by Schroeter (Krypt. Fora v. Schlesien (Cohn) 3:384. 1889): Fruit body waxy, flatly spread out or weakly swollen; hymenium waxy, smooth. Basidia crowded, divided by cross walls into mostly four cells. [In our Chapel Hill species into only 2-3 cells.] Spores single, colorless. Saccardo adds: spores, lunate, continuous, "producing no sporidia on sprouting (as it seems)." Nine species (none from North America) have been described, eight on wood, one on dung. All are quite small and easily overlooked. Our plants seems to be new. The genus Tachaphantium of Brefeld (l.c. p. 78) is not distinct from this.

Helicogloea of Patouillard (Bull. Soc. Myc. de France 8:121. 1892) is also not different from Platygloea.* One species *H. Lagerheimi* Pat. has been described. It is effused, hyaline, more or less tuberculose, cinereous, 4-5 cm. broad. Basidia 80-100μ long, 7-8μ thick, attentuated below, obtuse above, 3-4 spored. Spores hyaline

* Patouillard writes me: "The genus Helicogloea is not a good genus! It is a true Platygloea, which differs from the typical form in its texture of clay. At the most, it could be kept as a section of Platygloea."

PLATE 33



SACCOBLASTIA OVISPORA VAR. CAROLINIANA. No. 4078.

guttulate, 7-8 x 15μ, conidia ovoid, 7 x 12μ. On decaying wood in Equatoria. It may be our *P. Lagerstroemiae*, but there are discrepancies. For *P. effusa* see Trans. Brit. Myc. Soc. **6**:138. 1918.

KEY TO THE SPECIES

Plants pulvinate, not fusing into crust-like masses, sterile threads (paraphyses) absent in the hymenium........*P. caroliniana* (1)

Plants nodulose-crustose, sterile threads present in the hymenium ....*P. Lagerstroemiae* (2

1. Platygloea caroliniana n. sp.*

PLATE 54

Gregarious but not crowded, forming pulvinate, flattened patches 0.5-2.5 mm. broad and 0.5-1.5 mm. high, dull smoky flesh-color until old, then more sordid and less pink. Surface dull, granular-looking, convex when fresh, even in small plants, convoluted in larger ones, in age becoming flattened by collapse. Texture firmly waxy throughout. Spores (of No. 4199) sub-oval, smooth, not white, apparently yellowish or pinkish-yellow on a light spore print on a slide, 4-7 x 5-9μ, not divided. They sprout at or near one end to form smaller, secondary spores (sporidia) of more narrow and irregular shape, mostly pip-shaped, but soon becoming irregular or curved by sprouting. Basidia in dense groups of about 8-10, borne in a close corymb, 5.2-6.5 x 15-20μ, swollen, two-celled or some at least with a third, stalk-like cell, each cell sprouting by a rather long or a short sterigma parallel to the long axis of the basidium as in Auricularia.

Threads of the flesh not crowded, branching at open angles about 2-3.7μ thick, the cross walls usually about 55-100μ apart, but variable, no clamp connections, branching near the surface in a densely corymbose manner and terminating in the clusters of basidia. The plants have exactly the appearance of a small Dacrymyces, but the texture is waxy, not gelatinous. There is no discernible root entering the wood.

This cannot belong to the genus *Jola* of Möller, as that has basidia which do not arise in dense groups and which usually arise from a swollen stalk cell. The spores are very narrow, elongated, and curved (in *J. Hookeriana*, 6 x 28-36μ; in *J. javensis* 3-4 x 15-20μ). Moreover, of three species of Jola described all are parasitic on mosses.

*Just before going to press a letter comes from Patouillard, who says: "*P. caroliniana* is very different from *Helicogloea Lagerheimi* and is easily a good species."

We have decided to let this go for the present in the genus Platygloea, as it is certainly nearest that or Helicogloea Pat., which is very near or more probably the same, as Möller thinks. Our plant, however, has basidia with only two or three cells, and the absence of sterile cells mixed with the basidia is also a difference. It does not seem to agree with any described species of the genus or with *Helicogloea Lagerheimi*. *Platygloea blastomyces* Möller from South Brazil has basidia entirely too long and slender, spores 6 x 12μ. *Platygloea tiliae* (Bref.) Sacc. breaks through bark of Tilia; basidia four-celled, spores 12 x 35μ. *Platygloea Miedzyrzecensis* Bres. is pulvinate, 2-4 mm. in diameter, but the basidia are 3-5 septate, 4-6 x 75-200μ, the spores 7-9 x 10-13μ. (Ann. Myc. **1**:113. 1903).

4044. On corticated and decorticated branches of crepe myrtle (Lagerstroemia), January 28, 1920. Spores 3.7-4.5 x 5-7.5μ.

4199. On corticated and decorticated branches of crepe myrtle, March 5, 1920. Type.

2. **Platygloea Lagerstroemiae** n. sp.

PLATES 41 AND 54

At first forming very small pustules up to 1.5 mm. broad with indefinite margins which are usually crowded and densely gregarious, often fusing later to form elongated, more or less nodulated, irregular patches which may extend for 1-2 cm., not convoluted, the surface dull and granular looking; color at first pallid dull white or straw, soon sordid or smoky brown; texture firmly waxy. Hymenium composed of an immense number of small threads, formed by the corymbose branching of the inner threads, among which are the much thicker and elongated, curved basidia which also arise in corymbose clusters of several.

Basidia 5-5.5μ thick, elongated, irregularly curved and bent, usually two-celled, often with a slender basal cell which collapses soon; sterigmata terminal on each cell, ascending, long or short. The basidium begins to collapse while the spores are being formed and its shape is very soon lost. Basidiospores oval or elliptic, usually curved, very soon becoming irregular and often cycle-shaped by sprouting, 4-7.4 x 7.4-12.3μ, the secondary spores of the same shape, the smaller sizes almost certainly secondary, the smaller secondary spores are 1.6-3.7 x 3-5.5μ.

This is quite distinct from the preceding species, differing in presence of sterile threads in the hymenium, in fused and crust-like form with indefinite margin, in color, in larger spores which are more curved and in larger basidia. The form and habit are more like those of a Sebacina than a Dacrymyces. This seems near Möller's *Platygloea blastomyces* from South Brazil, but differs in the thicker and shorter basidia. *Platygloea effusa* Schroeter is also near, but has basidia with four cells and the color is said to be bluish to yellowish white.

4062. On bark or dead limb of crepe myrtle (Lagerstroemia), February 3, 1920. Photo. Type.

SEPTOBASIDIUM

A curious and anomalous genus forming a resupinate crust on living twigs and branches that are usually and probably always infested with scale insects; supposed to be parasitic on these insects. The plants seem more nearly related to the rusts than the higher basidiomycetes, for the basidium arises from a previously formed, subspherical to pyriform cell, suggesting a one-celled teliospore, and is, when mature, elongated, curved and divided across into cells which give off the long, bent, white spores at right angles on short sterigmata. These structures have been imperfectly or incorrectly understood. Texture coriaceous and resembling a Corticium. Of the seventeen species recorded by Burt two are reported from North Carolina. See Burt in Ann. Mo. Bot. Gard. **3**:319. 1916. Also Lloyd: Myc. Notes **51**:720. 1917; and **61**:887. 1919.

KEY TO THE SPECIES

Surface rugose-wrinkled like some lichens........................*S. retiforme* (2)
Surface even
  Paraphyses bent over and interwoven at the surface ....*S. pseudopedicellatum* (1)
  Paraphyses straight or nearly so....................................*S. Schweinitzii* (3)

1. Septobasidium pseudopedicellatum Burt.

PLATES 34, 66, AND 67

Plant forming a felt-like, thickish crust usually about 2-5 cm. long and 1-2.5 cm. broad; surface smooth until broken up in age, whitish when young, then passing through pale brown to avellaneous or wood

brown and in age blackish brown; dull, not shining, the uneven margin somewhat fimbriated. Substance internally spongy and open, soon composed of delicate little fibrous pillars supporting the dense upper layer and springing below from a thin, superficial layer on the wood. Basidia-bearing cells (protobasidia) thick, single, terminal, surrounded by slender, bent, interwoven threads. Hyphae loosely packed, considerably branched, rarely septate, no clamp connections.

Basidia appearing in spring from the distal ends of the resting cells, irregularly cylindrical or club-shaped, the tip cell pointed at maturity; sterigmata lateral or, on the top cell, apical.

Spores (of No. 4293, print) white, smooth, long, curved, soon divided into about eight cells, $3.5\text{-}4.7 \times 15.5\text{-}20\mu$, sprouting in water into small sporidia which are $1\text{-}1.8 \times 3\text{-}6\mu$, or rarely sprouting without dividing into a single large secondary spore about $3 \times 12\mu$. The length of the basidiospores is quite variable. In No. 4286 they were, from a print, $3.7\text{-}5 \times 18\text{-}30\mu$.

This species attacks colonies of scale insects (*Chrysomphalus obscurus*)* on living bark and at first is a thin weft of pure white threads running over and among the scales; soon it becomes thicker, the insects become more obscured and are finally hidden completely. About this time there appear numerous free, upright, thread-like fascicles of woven hyphae about 1 mm. high, which gives the plant a peculiar hairy appearance at this stage. We have not followed the life history fully as yet, but it seems probable that these fascicles are to become the supporting columns to the upper layer and that they form this layer by later proliferation and fusion of their tips. The plant is parasitic on the insects only and does not injure the tree.

Burt remarks that in this species the spores are formed in May. In Chapel Hill we find in January and February apparently grown and fully thickened patches of the fungus that are still pure white; at the same time are found more mature brown patches, some of which are breaking up from age. Both the white and brown patches show fully formed resting cells near the surface, but younger, less mature white patches show none of these. In late April we find the basidia appearing and forming spores. If placed in a damp chamber after soaking basidia will appear and form spores in about two days. We have noticed that while the insects themselves were only dead shells under

* Determined by Mr. Harold Morrison of the Bureau of Entomology, Washington, D. C. Dr. Speare of the same Bureau finds associated with our specimen another parasite of scale insects, the fungus *Myriangium duriaei*.

PLATE 34

SEPTOBASIDIUM PSEUDOPEDICELLATUM. No. 236

the thick white crusts in January, their eggs were apparently in good condition, being plump and juicy. The species is common in Chapel Hill on willow oak, water oak and hornbeam, and we have found it on privet, apple, alder, white oak, pin oak, *Ilex decidua* and *Cornus amomum*.

3923. On live branches of privet by President's home and by Raleigh road, January 9, 1920.
3924. On a recently dead limb of ironwood (*Carpinus caroliniana*) in Arboretum, January, 9, 1920.
3936. On branches and trunk of *Quercus nigra* by Morgan's Creek, opposite Laurel Hill, January 11, 1920. Photo.
3943. On live limb of willow oak in Arboretum, January 15, 1920.
4015. On alder limbs by branch below Cobb's Terrace, January 24, 1920.
4112. On young, living ironwood near Battle's Branch, February 13, 1920.
4157. On apple bark (living) in Dr. Herty's yard, February 21, 1920.
4286. On live branches of *Q. Phellos*, Rocky Ridge Farm, April 25, 1920.

2. **Septobasidium retiforme** (B. & C.) Pat.

PLATES 65, 66, AND 67

Plants forming resupinate, firmly attached, rather hard and tough, thickish crusts with the surface rugose-veined very much like some foliaceous lichens; margin thinner, irregular and whitish; color deep drab brown and finally darker brown, the margin paler. Substance about 2.3-0.5 mm. thick, brown, the central part less dense and composed of upright fibers somewhat loosely packed, but appearing solid under a hand lens. In old crusts this central part collapses first, leaving the outer and inner layers.

In the S. C. collection, made in December, the basidia were just appearing as undeveloped thickenings. Burt found only one spore in his material, so that the spore characters remained uncertain until we found spores plentiful in our No. 4279. Resting cells when mature oval, sprouting in April to form apical basidia. Spores (of No. 4279, print) long, white, curved, 3.8-5.5 x 17.3-27.5μ, if kept damp dividing soon into about six to eight cells and sprouting by minute sterigmata into oval sporidia, much as in *S. pseudopedicellatum*. Basidia 7-8 x 52-60μ, arising from the tip of the resting cells, 4-celled remarkable in that they fall from the resting cells as soon as fully formed, at least if formed in water; sprouting after falling off into the four spores from lateral sterigmata. In the distal cell the sterigma may be terminal or nearly so. The plant, like the preceding species, grows on plant lice, which are very obvious in

our material. It does not seem to have been reported from either of the Carolinas before, but has been found in the District of Columbia and as far south as Cuba. It is said to grow on apple, pear and peach, as well as other trees.

4279. On live branches of *Q. Phellos*, Rocky Ridge Farm, April 25, 1920.

4294. On the same tree as No. 4279, May 3, 1920.

Hartsville, S. C., on water oak (*Q. niger*), December 25, 1919. Coker.

3. **Septobasidium Schweinitzii** Burt

This is much like *S. pseudopedicellatum*, but is said to differ in the tips of the paraphyses being upright instead of bent and interwoven horizontally. It was originally described from North Carolina as *Thelephora pedicellata*. We have not found it.

North Carolina. Schweinitz.

SIROBASIDIACEAE

Plant gelatinous, soft, pulvinate, small; basidia arranged in chains, divided either into two cells by an oblique septum or into four cells by two longitudinal septa, each cell producing one spore. There is but one genus.

SIROBASIDIUM

As there is but one genus, it may be defined as having the characters of the family. We have found one species in Chapel Hill, and as the genus has heretofore been known only from South America, this adds a genus to the North American flora so far as reported, but Dr. Farlow has collected a minute species of this genus, practically invisible without a lens, on twigs of Viburnum (?) at Chocorua, N. H.

Sirobasidium Brefeldianum Möller

PLATE 55

Forming minute, little pustules about 0.4-1.3 mm. in diameter and 0.2-0.5 mm. high, gregarious but not crowded, smooth, softly gelatinous, not viscid, but slippery, watery-smoky to dusky white (with a tint of flesh in some).

Spores ovate, smooth, hyaline, varying in size, most about 7.5-8.1 x 13.3-13.7μ, sprouting soon to form small oval sporidia. Basidia 10.5-12.6 x 22-40μ, borne up to 6 (or more ?) in chains, pear-shaped, usually with a narrowed base, divided into two cells by an oblique cross wall, each cell sprouting near the apex to form a single spore.

The minute size and obscure color render the plant almost invisible in passing. The plant seems to agree well with *S. Brefeldianum* of South Brazil (see Möller) and adds a genus to the North American flora. Two other species, *S. albidum* Lag. & Pat. and *S. sanguineum* Lag. & Pat., have the basidia divided into four cells by longitudinal or slightly oblique septa. They are both from Ecquador (see Jour. Bot. **6**:465. 1892).

4104. On decorticated rotting branch of *Albizzia julibrissin*, Episcopal churchyard, February 13, 1920.

TREMELLACEAE

Plants growing on wood, more or less gelatinous and translucent, toughish or soft, shrinking and becoming hard on drying, sometimes shelving and irregularly cup-shaped or ear-like, more often irregularly folded and lobed or brain-like or forming simple cushions; in another group thin, tough and leathery or coriaceous, and encrusting wood as in the Corticiums; in one genus (Tremellodon) with an eccentric cap and teeth like a Hydnum on the under surface. Hymenium covering all the exposed surface of the body (as in Tremella) or only the lower surface (as in Tremellodon). Basidia spherical or ovate or pear-shaped, divided into four cells by longitudinal or oblique walls. Basidiospores smooth, subglobose, pip-shaped, broadly elliptic, or elongated and curved; color various. Not yet reported from America are the genera *Protodontia* and *Protohydnum* (See Trans. Brit. Myc. Soc. **6**:69. 1917).

See Tulasne: *Observations L'organisation des Tremellinees.* Ann. Sci. Nat. 3rd series, **19**:193. 1853. Also Tulasne: *Les Fungi Tremellini et leurs Allies*, l.c. 5th series, **15**:215. 1872. (Also the same in English in Proceedings Linnean Soc. **13**:31. 1873). Brefeld: *Untersuchungen aus dem Gesamtgebiete der Mycologie.* Heft. **7**:80. 1888. Gilbert: *Studies on the Tremellineae of Wisconsin.* Transactions, Wis. Acad. Sci. **16**:1137. Pls. 82, 84. 1910. (This gives references to the literature). Morgan: *Myc. Flora Miami Valley.* Journ. Cin. Soc. Nat. Hist. **11**:91. 1888.

KEY TO THE GENERA

Texture gelatinous; shrinking greatly on drying, and reviving again when moistened.
  Hymenium (spore-bearing surface) without spines.
    Spores white, elongated and a little curved like a sausage
      Plants without a central body of different tex-

ture .... *Exidia*
Plants containing several small seed-like bodies, which become quite conspicuous on drying (in N. *atrata* Pk. the central body is said to be black) .... *Naematelia nucleata*
Spores white or yellow to orange (*T. colorata* Pk. is said to have raisin-colored spores), spherical or broadly elliptic or pip-shaped, not curved........ *Tremella*
Plants containing a firm, white, central body or a folded white membrane; surface minutely rough... *Naematelia*
Hymenium with spines .... *Tremellodon*
Texture fibrous and leathery or toughly coriaceous or varying to waxy; not shrinking greatly on drying.
Plant growing from the ground, resembling a Thelephora, tough, firm, much branched from a fused base; tips white .... *Tremellodendron*
Plant growing on wood, tough, leathery, resembling a Corticium or a little Stereum; hymenium pink in our one species.. *Eichleriella*
Plant resupinate on wood or encrusting the bases of plants or objects from the ground; white or buff or gray in our species.................................... *Sebacina*

EXIDIA

Plants pulvinate, convoluted, gelatinous, in some species with small surface papillae or dots, often compounded in lines or masses; arising from a small central point or elongated plate; all the exposed surface bearing the hymenium or only one surface in the more or less flabelliform *E. gelatinosa*. Basidia pyriform to subspherical, divided lengthwise into four cells, each cell with a long sterigma with a spore at its tip. Spores elongated, curved, white, mostly two-celled before sprouting.

Brefeld has established a genus *Ulocolla* for plants like Exidia that form straight, rod-like sporidia in sprouting, the true Exidias sprouting to form groups of much curved, almost circular sporidia. He retains *E. gelatinosa* and *E. glandulosa* in Exidia, placing in Ulocolla *E. saccharina* Fr. and also *Tremella foliacea* Pers., which he thinks may not be distinct from the preceding. Brefeld erects still another genus, *Craterocolla* for dimorphic tremulose plants with spores like Exidia, and he transfers to that genus *Tremella Cerasi* Schum. (l.c. p. 98).

KEY TO THE SPECIES*

Plant raisin color, set with small darker specks on the sterile side .... *E. gelatinosa* (1)
Plant dark, blackish-brown, usually with small scattered papillae on exposed surface .... *E. glandulosa* (2)
Plant raisin color to sordid clay color without specks or papillae .... *E. Beardsleei* (3)

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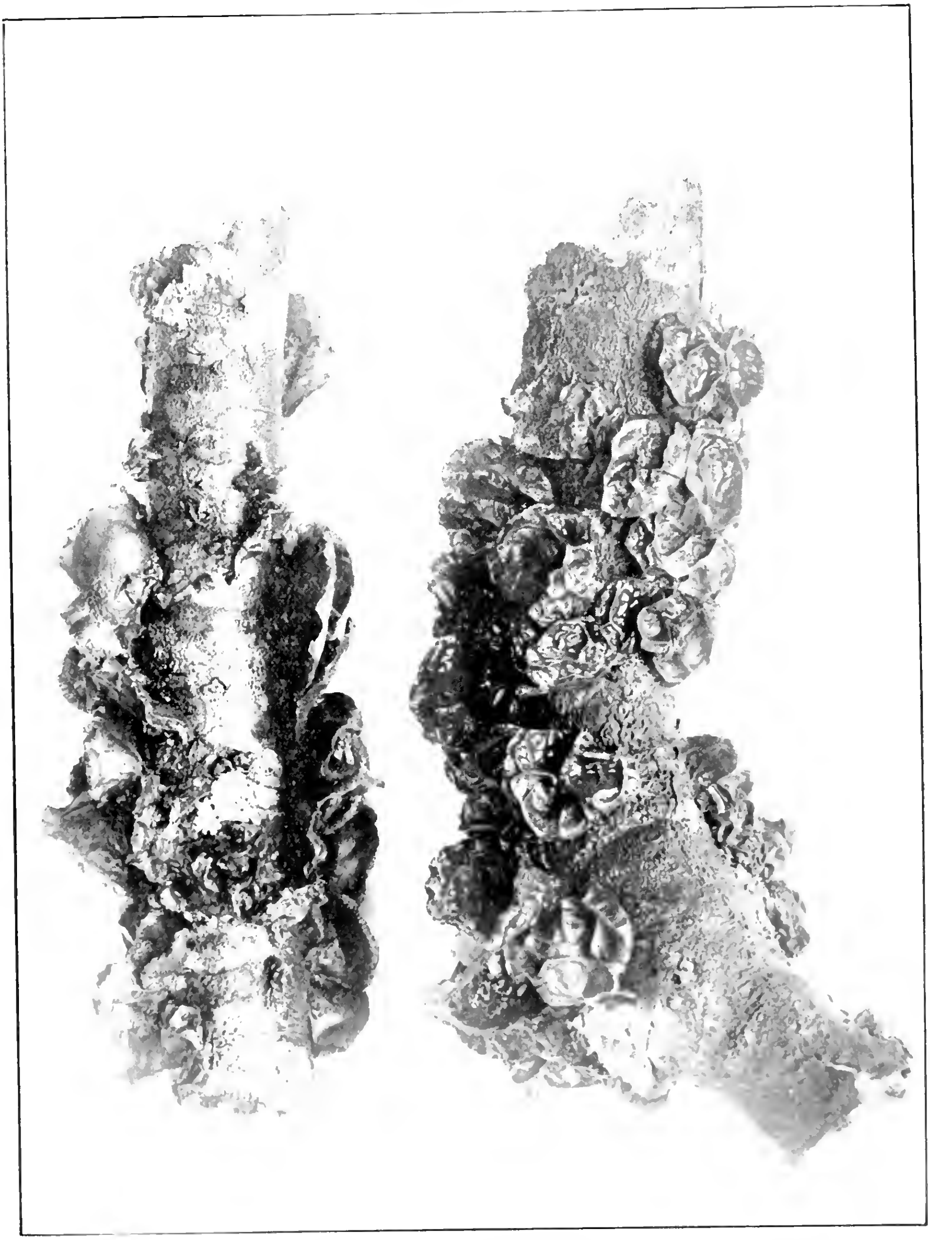
* For notes on other species see pages 150, 151.

PLATE 35



EXIDIA GELATINOSA. No. 4091.

1. **Exidia gelatinosa** (Bull.) Schroet.
E. recisa (Dittm.) Fr.
Tremella corrugata Schw.
Tremella crenata Schw.

PLATES 35 AND 55

Plant if horizontal from the sides of branches forming flattened, shelving, bracket-like caps; if borne on top or beneath the branch they form crumpled, rather shapeless, more or less flattened masses which are attached by a point or by a more extensive area to the wood; dorsal surface sterile, wet-looking and when seen with a lens showing minute, dark dots; hymenial surface dryer and glaucous from the projecting sterigmata and spores, ridged irregularly like an ear as in Hirneola; there are no papillate projections as in *E. glandulosa*. Texture soft and gelatinous but holding its shape; not so firm as Hirneola, which it rather resembles in form and in the deep blackish wine color; black and shrunken and shapeless when dry. Internal hyphae of fruiting body 2μ in diameter; with cross walls but no clamp connections.

Basidia much as in Tremella, oval and divided into four cells by two longitudinal walls, each cell with a long sterigmata which projects considerably above the surface. Basidia short-oval, 9-10 x 11-11.3μ, situated at and near the surface to a depth of 45μ. Spores white, smooth, sausage-shaped, 3.8-4.5 x 11.2-13.4μ.

Under a microscope the black dots on the dorsal surface are seen to be crusty-looking patches partly embedded and partly free and with much the appearance of small, thickish flakes of bark. These furnish an unfailing means of determination. The absence of the papillae and the flattened form also distinguish this from *E. glandulosa*, while the sausage-shaped spores and smaller size separate it from *Tremella frondosa*.

Very common on fallen oak branches of various species and conspicuous in wet weather. Also on grape, *Prunus*, sweet gum, and elm. Gilbert's figs. 5 and 6 (l.c. Pl. 82) are good of our plant. Brefeld's figure also is good (l.c. Pl. 5, fig. 19). Bulliard's plate 460 (as *Peziza gelatinosa*) gives a poor impression of the habit. For the hymenium and spores see Tulasne l.c. Pl. 12, fig. 2. 1853. From an examination of a collection in the Schweinitz Herbarium I find that *Tremella corrugata* is this species. It has the same characteristic encrusting

1

particles on the dorsal surface, and there was nothing in the microscopic structure to contradict this. No spores were found. *Tremella crenata* is also the same, the crustaceous particles showing up plainly on wetting in a good specimen from the Schweinitz Herbarium (see page 151). Bresadola has found in the Trentino a plant much like *E. gelatinosa*, but growing on coniferous wood, to which he gives the name *E. umbrinella*. It has not been reported from America, but I find on examination of Peck's type that his *Tremella pinicola* is very like it if not the same (see note on page 150).

116*a*. On dead oak wood by Battle's Branch, December 2, 1913.
3854. Fallen oak limbs, east and southwest of old Graded School, December 9, 1919. Photo.
3900. On fallen branch of white oak, December 13, 1919.
3901. On fallen oak branch, December 13, 1919.
3938. On dead branch of *Prunus serotina* in Arboretum, January 13, 1920.
4089. On grape vine (*V. rotundifolia*), February 4 and 20, 1920. Basidia oval, four-celled, 9.3 x 11μ. Spores smooth, white, curved, 3.7-4.8 x 9.3-13.5μ.
4091. On oak branches back of Athletic Field, January 17, 1920.
4114. On oak limb by Battle's Branch, February 13, 1920. Photo.

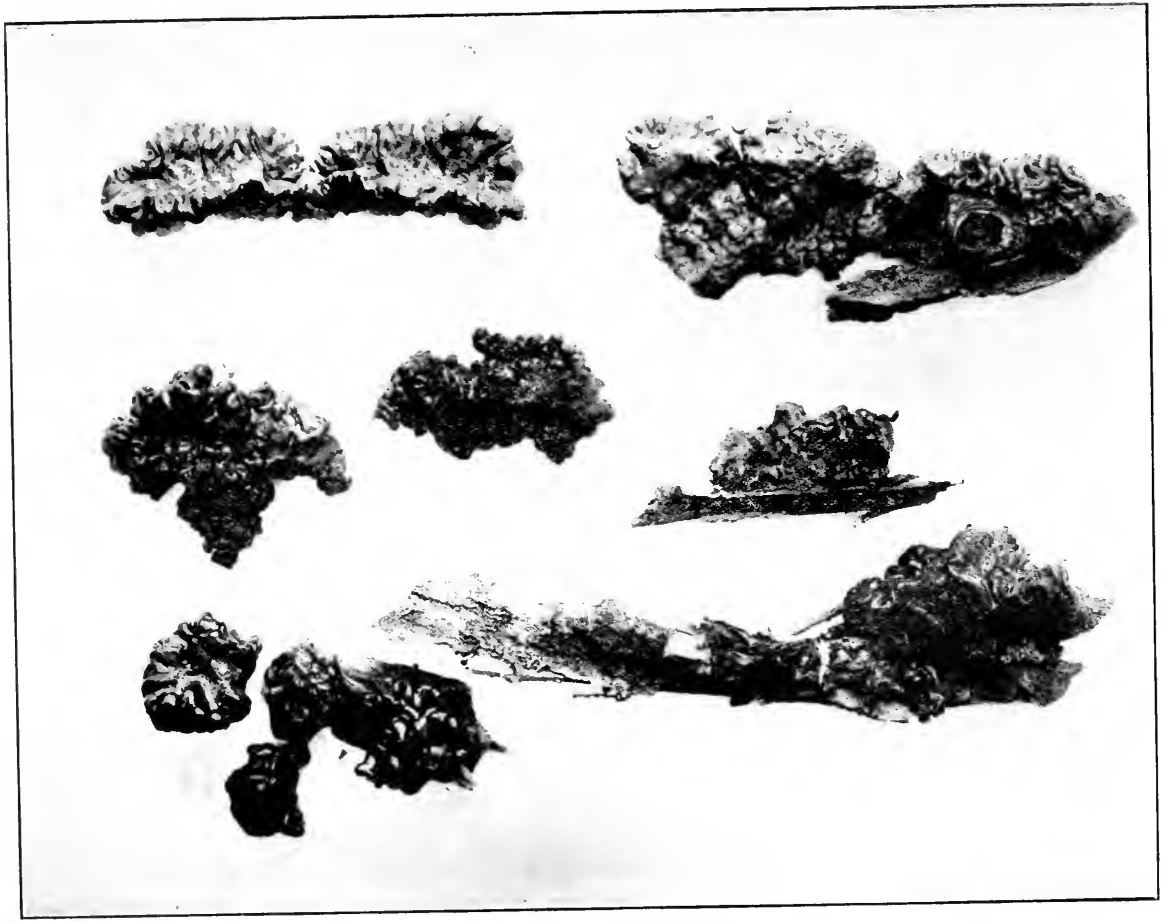
2. **Exidia glandulosa** (Bull.) Fr.

PLATES 36 AND 55

Plant forming convoluted, gelatinous, thickish, pillow-like masses which may be single or fused into long rows along cracks in the bark; narrowly attached and spreading out laterally; upper (outer) surface bearing basidia and faintly glaucous under a lens, also more or less conspicuously dotted in a scattered way with small, black, protruding warts or points; color deep blackish-brown, like very dark wine jelly, the lower surface a little paler, watery-shining and not glaucous or warted; when protected from light, plants are apt to be much paler, approaching white (No. 4198); texture rather firmly gelatinous, deliquescing only when long wet, not viscid. On drying the plants flatten down and collapse into a thin black membrane.

Spores smooth, white, rod-shaped, curved, 3.7-4.1 x 9-12.5μ. In sprouting the contents usually moves to one end, the empty end being cut off by a wall, the protoplasmic end sprouting at the mucro. At times both cells contain protoplasm and both sprout; again no cross wall is formed and the entire spore sprouts at the mucro. Basidia pear-shaped, four-celled by two longitudinal divisions.

PLATE 36



EXIDIA GLANDULOSA. No. 3878.

The smaller, single pustules are about 3 mm. wide and 2 mm. high, the longer, compound ones may reach a height of over a cm. and extend in more or less interrupted rows for a foot or more along the branches. This plant differs from *Exidia gelatinosa* in darker color, smaller size and pulvinate form which is quite unlike the thin, flattened, laterally attached caps of the latter. It also differs in the black papillae on the hymenial surface and the absence of the close-set, dark, inherent dots on the dorsal surface. Very common on many kinds of deciduous trees and shrubs, as on privet, osage orange, Baccharis and others, besides those mentioned below. Individual pustules are often without papillae, and such are probably *E. epapillata* Bref. and *Tremella intumescens* Sm. Brefeld gives the spores of the European *E. glandulosa* as 5 x 14μ which is a little larger than in ours. *Exidia plicata* Klotzsch seems to be another European form on alder with few papillae and slightly longer spores, up to 20μ.

3878. In fallen branch of willow (*Salix nigra*) in Arboretum, December 13, 1919. Photo.

3933. On dead stems of trumpet vine (*Tecoma radicans*), January 9, 1920. Spores as in No. 3878, 3.7-4.5 x 10-13μ.

3951. On *Vitis aestivalis*, January 17, 1920. Basidia 9.3-11 x 11-14μ.

3973. On white birch (*B. alba*) in Arboretum, January 18, 1920.

4188. On oak bark, Strowd's lowgrounds, February 25, 1920.

4198. On oak stick under leaves, March 2, 1920. Basidia oval, 10-11.8 x 14-15μ. Spores 3.7-4.5 x 8-14μ.

3. Exidia Beardsleei

PLATE 56

The following is by Mr. C. G. Lloyd:

"Sessile, cushion shape, gyrose, lobed. Color of a raisin. Flesh same color. Papillae none. Basidia globose, 8-10μ, very pale color. Spores hyaline, 5 x 10μ, slightly curved, unilateral, apiculate.

"Were we to determine this from books we should call it *Exidia saccharina*, but we know this in Europe and it is not that species. The color might be compared to brown sugar but better to a raisin. We do not find it in Ridgway, but pecan brown is not far away. While it has no papillae we put it in Exidia on the spores. As previously stated the line between Tremella and Exidia is hard to draw. In general appearance this is rather a Tremella. The color is somewhat like that of *Naematelia nucleata* when old. It dried away leaving hardly a trace on the bark. It grew on frondose wood. From W. C. Coker, North Carolina (No. 4021).

"We published this, Myc. Notes No. 61, p. 898, as *Exidia Uva Passa* (in duplicate) having used this name (54, 774) for a plant from Japan. We are not sure that our American plant is different from the Japanese, but it appears to us to have a more reddish color and smaller spores but it is practically the same."

In accordance with his well-known principles, Mr. Lloyd does not wish the above species name, here first used, to be followed by his name, and I have left it off at his specific request. We have found the plant three times in Chapel Hill, as is indicated by the collection numbers below. Our notes on No. 3930 are as follows (the figures on Plate 56 are ours):

Plant forming small, simple or more complicated pulvinate patches from 1-7 mm. broad and 1-2 mm. thick; surface, unless quite small, with folds like a brain; surface farinose with spores, not papillate, or with a few small, obscure warts, not viscid; color a dull sordid clay; texture firmly gelatinous.

Spores (of No. 3930) white, smooth, rod-elliptic, some a little bent, 4-4.8 x 7.7-11.4μ, a few up to 6.7 x 14.8μ. Basidia (of No. 4191) short-ovate, 9-10 x 11-11.8μ.

When dry the plant collapses down to a thin, scarcely visible, sordid brown membrane which is about the same color as the bark. This cannot be *E. sucina* Möller from Brazil which has similar basidia and spores (basidia 10-12μ, spores 4-5 x 10-12μ) for that is amber yellow in color (a "clear yellow," he says in another place), and is particularly characterized by numerous peculiar enlarged and elongated cells with yellow contents which run from the layer below the basidia up to but not beyond the surface. They are 66-80μ long and 6-8μ thick (Möller l.c. p. 95).

3930. On dead branch of *Robinia pseudacacia* with bark on, January 10, 1920.

4021. On *Robinia* branches on tree, January 24, 1920. Like No. 3930. In drying shrinking down to a nearly black membrane. No white nuclei. Spores white, elliptic, some curved, 3.7-5 x 7.4-11μ. Type.

4191. On decorticated oak wood, February 26, 1920. Color of plant dull reddish amber. Spores smooth, curved, 3.7-4.4 x 8-11.8μ.

NAEMATELIA

Resembling the cushion-shaped Tremellas in form, but differing in the presence of a firm, white or yellowish (said to be black in *N. atrata* Pk.) non-gelatinous central body or membrane which is surrounded by the gelatinous, translucent portion. In drying the gelatinous part shrinks to a membrane and leaves the unshrunken inner whitish part more conspicuous. The genus was established by Fries with *N. encephala* as the typical species (being the first mentioned). He also included *N. nucleata* (*T. nucleata* Schw.), a plant too different in its spores and in the presence of scattered white nuclei to be

eogeneric. It would be just as well probably to place this latter species in the genus Exidia, which differs only in the absence of white nuclei. We retain it here, however, for the present. For article on a supposed Naematelia see Trans. Brit. Myc. Soc. p. 143. 1899-1900.

KEY TO THE SPECIES

Growing on deciduous woods
    Orange yellow; spores subspherical ....*N. quercina* (1)
    Dull ochraceous or smoky clay to wine color;
        spores elongated as in Exidia ....*N. nucleata* (2)
Growing on pine; light flesh-color, then brownish ....*N. encephala* (3)

1. **Naematelia quercina** n. sp.

PLATES 23 AND 58

Plant forming good sized masses of crumpled and flattened folds which are not hollow and which extend upward about 1.5-2 cm. and laterally about 2-3.5 cm., the surface not smooth but characteristically roughened all over under a lens like a cockscomb; color orange-yellow inside and out except for a thin white membrane about 0.7 mm. from the surface which follows all the convolutions and gives a marbled appearance to cut surface. Texture tough and firmly gelatinous, the surface opaque, only the internal part translucent and paler. The plant enters the bark by a flattened constricted brownish base.

Spores orange-yellow, spherical or short-oval, smooth, 7.4-11μ in diameter. Basidia spherical, divided into four cells by longitudinal walls, 15-20μ in diameter.

This is easily distinguished by the deep color, good size, firm texture, absence of hollows, and by the rough surface and white internal membrane. I have been able to find almost none of this plant in American herbaria, the only two specimens that I am sure of being the same are a plant from Ellis (Newfield, N. J.) in the Farlow Herbarium and one in the Curtis Herbarium from Society Hill, S. C. The former is labelled by Ellis *Naematelia* sp.? It has the same rough surface and white interior. The latter is labelled *T. aurantia* Schw. but is nothing like that species, which is a Dacrymyces. Its basidia are 15-19μ thick, four-parted; the spores 9-10μ thick, subspherical. *Naematelia encephala* Fr. on bark of Abies as represented in the Farlow Herbarium (Vermont, New Hampshire, etc.) has the same peculiar surface and white interior. A plant from Bresadola (New York Botanical Garden) on oak bark called by him *N. encephala* is like our *N. quercina* in surface characters and the basidia are nearly spherical, 14-17μ

thick, but the color is more of a fleshy tan (see also under *N. encephala*). This is probably what he later named *T. encephala* var. *Steidlerii* which agrees well with our plant except that he says the color of the plant is brown and the spores hyaline (Ann. Myc. 6:42. 1908). Lloyd thinks our plants are *T. mesenterica*, but I am satisfied that it cannot be that species, if indeed that is different from *T. lutescens*. The genus Naematelia may be taken as based on the species *N. encephala* and it seems to me that our plant is sufficiently like it to be placed in the same genus. *Tremella nucleata* Schw., placed in Naematelia by Fries is too different to be eogeneric with the other two, and would probably just as well be put in the genus Exidia.

3935. On oak wood in a wood pile, pushing through cracks in bark, January 18, 1920. Painting. Type.

4111. Deciduous twig by path north of Piney Prospect, February 13, 1920. Surface roughened, the white internal membrane barely showing, not hollow. Plant old and in part turned nearly white, other part watery orange.

2. **Naematelia nucleata** (Schw.) Fr.

PLATES 23, 41 AND 56

Small, pulvinate, nearly even or more often convoluted, flattish or convex or in larger plants pinched up in center; 1-6 mm. in diameter, often crowded into lines which may be up to 1-2 cm. long; gelatinous, translucent; color quite variable, a clear wine color or dull reddish-brown or faded to a pallid watery wine or dusky amber or nearly hyaline; not glaucous; the habit very like that of *Exidia glandulosa*. In the fresh state the whitish, seed-like nuclei may or may not be apparent even though they may show up on drying. Not a few plants of a good sized colony show no nuclei even when dry, and such if found alone would be referred to Exidia. The nuclei are irregularly scattered through the plant and are often so small as to be nearly invisible without a lens. They rarely reach a quarter mm. in diameter.

Spores (of No. 3959) white, curved-elliptic, $3.7\text{-}4.2 \times 7.4\text{-}11\mu$. Basidia spherical, $10.5\text{-}11 \times 11\text{-}11.5\mu$.

Schweinitz's description is misleading, but that this is his plant is not open to doubt. A collection from him in the Schweinitz Herbarium looks just like ours with scattered seed-like nuclei. Under the name of *Tremella albida* in the Curtis Herbarium are a variety of plants. One of these from England (Broome) is *N. nucleata*. Another from Massachusetts (Sprague) is a Dacrymyces.

3956. On corticated branch of *Salix nigra*, in Arboretum, January 17, 1920. In this collection the basidia are slightly more elongated than in other numbers, being 8.5-9.3 x 11μ, mostly divided lengthwise into four cells. Spores white, smooth, a little bent, 4-4.5 x 9.3-11μ, apparently one-celled when shed.

3957. On a quite rotten, decorticated branch of English walnut, January 17, 1920. Basidia oval, 9.3μ thick. Spores smooth, bent-elliptic, 3.4-4.2 x 7.4-11μ.

3958. On a decorticated branch of a frondose tree under a grape arbor, January 17, 1920. Plants like No. 3961 in every way except that these are smaller, the pustules being from less than 1 mm. to about 2 mm. broad. Basidia nearly spherical, divided into four cells. Spores curved-elliptic, white, 3.7-4.4 x 8-11.4μ.

3959. On vine of summer grape (*Vitis aestivalis*), January 17, 1920.

3960. On dead vine of scuppernong grape on an arbor, January 17, 1920.

3961. On a small branch of a deciduous tree on ground under grape arbor, January 17, 1920. Painting. Spores allantoid, pure white (print), 3.5-4 x 7.7-14.8μ. Basidia nearly spherical, 9 x 10μ. In the fresh state a few of the plants show small white nuclei.

4023. On bark of standing dead *Salix nigra* in Arboretum, January 24, 1920. Habit of *Exidia glandulosa*, not papillate, faintly glaucous, at times crowded in rows up to 3.5 cm. long from a common, plate-like root. Spores 4-4.4 x 9-12μ. Basidia oval, 8.5-9.5μ thick, divided lengthwise into four cells. Painting.

4046. On *Ampelopsis tricuspidata*, January 28, 1920. A great variety of color shown in this lot, some watery white, others pale lavender or amber or reddish wine, etc., the whitish nuclei showing up at least when dried as little subspherical eggs that vary in number and size.

4154. On deciduous wood, February 21, 1920. Spores smooth, white, bent, 3.8-4.2 x 7.5-11.4μ.

4169. On an oak branch with bark, February 25, 1920.

4189. On oak in Strowd's lowgrounds, February 25, 1920. A fine collection with white nuclei very conspicuous.

North Carolina. Schweinitz.
Common on fallen limbs. Curtis.

3. **Naematelia encephaliformis** (Willd.).

The following is Fries' description from Epicrisis, p. 591 (as *N. encephala*):

"Subsessile, pulvinate, plicate-rugose, pallid flesh-color, at length brownish. Nucleus large, firm, white. . . . . Frequent on pine branches in winter."

The spores are given by Brefeld as like those of *T. globulus*, which are 15-18μ thick, oval; basidia large, oval (l.c. p. 128). But Bresadola after his description of var. *Steidlerii* on oak says that the spores of the typical form on pine are globose 8 x 8-9μ and not as Brefeld gives them (Ann. Myc. **6**:46. 1908).

A collection of this species from Fries on pine bark in the Curtis Herbarium is, in the dry state, about 3 mm. broad and 2 mm. high and the color of resin. Collections in the Farlow Herbarium from Vermont and New Hampshire on bark of Abies have a rough surface almost exactly like that of our *N. quercina*. This is also true of a collection in Schweinitz Herbarium on pine from Bethlehem. It is surprising to find that Bresadola has referred to this species a plant on oak bark. A specimen from him so labelled at the New York Botanical Garden is somewhat like my *N. quercina* but of a fleshy tan color. (See under *N. quercina*). Both Person and Fries use the specific name *encephala*, why, I do not know as Wildenow published it originally as *T. encephaliformis*.

Middle and upper districts, on fallen limbs. Curtis.
North Carolina (Salem?). Schweinitz.

TREMELLA

Plants firmly gelatinous, folded, lobed or wrinkled, or in one case with thick upright branches; color white, yellow, orange, brownish, whitish or pinkish or purplish or raisin color; becoming tough and horny when dry and, in most species, shrinking greatly; basidia spherical to pyriform, longitudinally or obliquely divided into four equal or unequal cells, from each of which extends a long sterigma with a subglobose or pip-shaped, or broadly elliptic, white, yellowish, purplish or umbrinous spore on the end. The spores often sprout if put in water as soon as shed, forming a rather short promycelium or sterigma with a single round or broadly elliptic spore on the end, or they may form numerous small sporidia as buds from the surface. The species with spherical or plumply elliptic spores form a natural group and are typical Tremellas. *Tremella reticulata* with upright, hollow branches and pip-shaped spores should be placed in a separate genus. None is known to be harmful. For development of basidia see Wager in The Naturalist **695**:364. 1914.

The plant growing parasitically on *Collybia driophila* and named by Peck *Tremella mycetophila*, was referred by Burt to Exobasidium

PLATE 37

TREMELLA RETICULATA. No. 2690.

(Bull. Torr. Bot. Club, **28**:287. 1901), but he now considers it an abnormal excrescence of the mushroom itself (Ann. Mo. Bot. Gard. **2**:656. 1915). We have found it here.

KEY TO THE SPECIES INCLUDED

Plants growing upright from the ground, with stout, hollow branches ..... *T. reticulata* (1)
Plants with thin, complicated, flattened, crowded, or open lobes; spores subspherical or jug-shaped, white.
  Color nearly pure translucent white ..... *T. fuciformis* (2)
  Color a translucent fleshy brown or raisin-clay or a deeper raisin color
    Spores subspherical, plant large
      Surface quite smooth; spores less than 8μ thick ..... *T. frondosa* (3)
      Surface roughish; spores more than 8μ thick.. *T. aspera* (4)
    Spores jug-shaped, plant small ..... *T. auricularia* (5)
Plants forming dense yellow or orange masses composed of folded and more or less flattened lobes; spores yellowish or orange.
  Growing on decidious wood..... *T. lutescens* (6)
  Growing on pine ..... *T. pinicola* (7)
Plants forming pulpy, diffused, amber-colored masses on dogwood or oak branches; spores pale, broadly elliptic ..... *T. virens* (8)
Plants forming small, irregular, convex, whitish or pinkish or creamy and usually much crowded cushions with brain-like folds; spores white..... *T. carneoalba* (9)
Plants in form like the above, but color pallid brown to wine-brown and when dry nearly black..... *T. subanomala* (10)
Plants in form something like the above, but purplish, almost black ..... *E. moriformis* (11)

1. **Tremella reticulata** (Berk.) Farlow.

? *Tremella vesicaria* Bull.
Sebacina tremellosa E. & E.

PLATES 37 AND 56

Plants 4.5-8.5 cm. high, 4-5.5 cm. broad in our collection, reaching at times a greater width, arising in a contorted and complicated way from the ground, and composed of more or less fused and anastomosing branches which end in blunt tips as in a coarse and dropsical Clavaria; color dull creamy white, not viscid, all parts hollow; semi-translucent, tough and elastic like a very firm jelly, not tremulose, almost tasteless and odorless.

Spores white, elliptic to pip-shaped, with a large mucro at one end, granular, smooth, 4.4-7 x 8-12.5μ. Basidia oval, 8.5-10.5 x 11-12.9μ.

This is the *T. fuciformis* of Atkinson's American Fungi, fig. 196, but I am following Farlow who seems to be right in determining it as *T. reticulata* (see Rhodora **10**:9. 1908). Lloyd thinks our plants are the same that pass in Europe as *T. vesicaria* (see Bulliard's Pl. 427), but that it is not the true species of Bulliard. See also a good photo by Lloyd in Myc. Notes, Old Sp. Series No. 1, fig. 224. 1908 (as *T. clavarioides*). His fig. 1562 in Myc. Notes **61**. 1919, as *T. sparassoidea*, is probably the same also. (See also Myc. Notes **62**: fig. 1646. 1920, and Mycologia **12**: 141, Pl. 10, fig. 3, 1920).

2690. Low damp woods by creek, upper Laurel Hill, July 17, 1917. Photo.

2. **Tremella fuciformis** Berk.

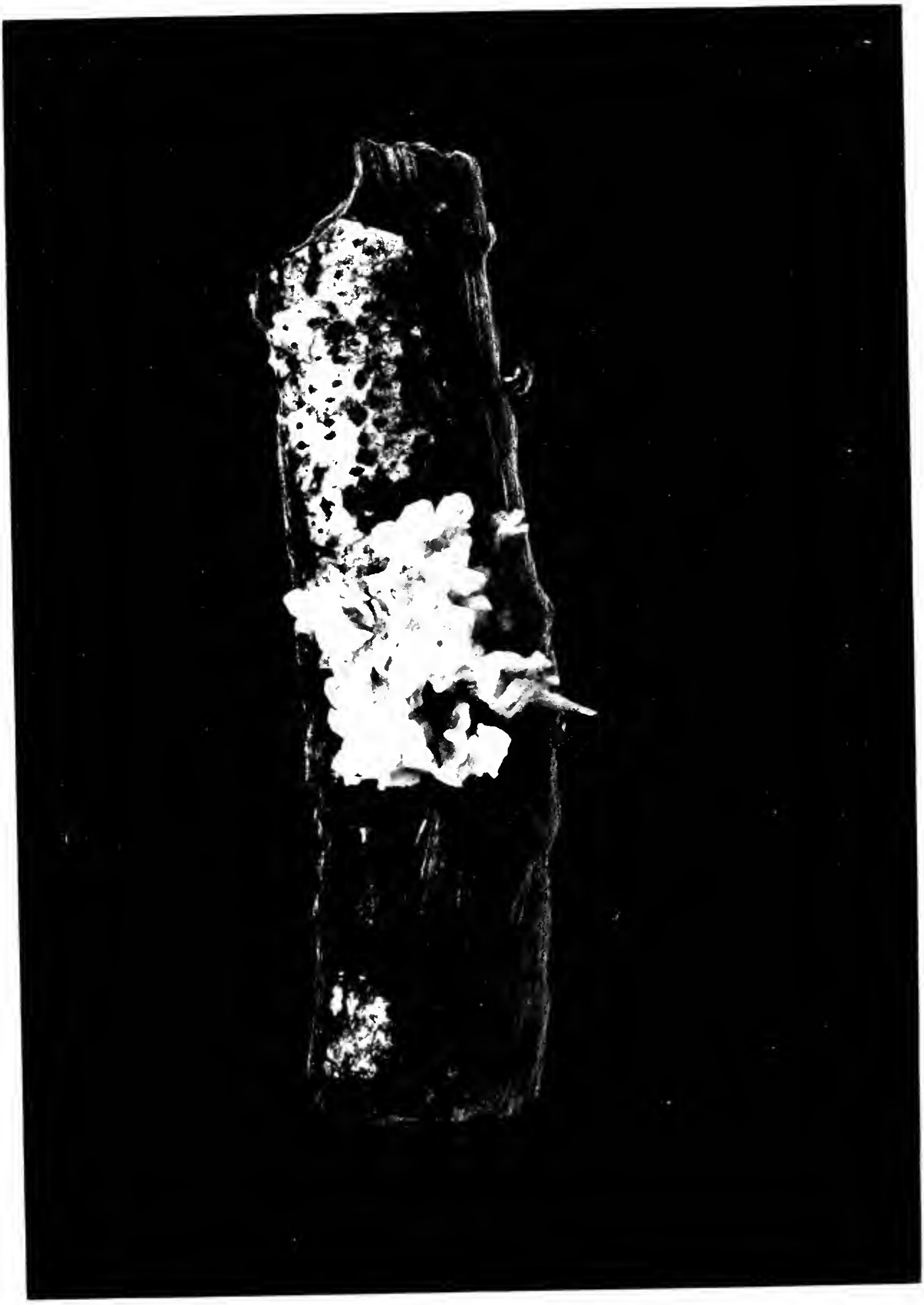
PLATES 38 AND 56

Plant forming a mass about 5 cm. long and 2 cm. high, composed of thin, flat, much crinkled and fluted lobes, texture tremulose, but quite tough; color a slightly soiled, translucent white.

Spores white, subglobose, smooth with a large oil drop, about 6.2μ in diameter. Basidia divided longitudinally into four cells, short and thick with long sterigmata.

According to Lloyd this is the true *T. fuciformis*, and is, he says, the third specimen known from the United States (but see notes under *T. lutescens*). The species was described from the Amazon and later recorded from Cuba and Jamaica and only reaches our southern states, the Orange County collections being the most northern record (see Farlow in Rhodora **10**:10. 1908). In a letter to me of September 3, 1918, Lloyd says that it has probably passed with southern "collectors as '*Tremella albida*,' our common, white northern species. But *Tremella albida* of America is an entirely different plant from *Tremella albida* of England." (See also Myc. Notes No. **55**:790, fig. 1188. 1918. Also *ibid.*, No. **40**:556. 1916). *Tremella albida* of Europe is now known by most authors as *Exidia albida* (Huds.) Bref. and differs sharply from our No. 1408 in the elongated, curved spores (4-6 x 12-14μ Karsten). The figure given by Möller of *T. fuciformis* (from Brazil) in his Protobasidiomyceten, Pl. 1, fig. 5 (1895), is like our plant in all essentials. See also the good photo by Lloyd mentioned above. The spores agree with Möller's measurements. For illustrations see Gilbert in Trans. Wis. Acad. **16**: Pl. 83, figs. 17-22. 1910. *Dacrymyces pellucidus* Schw. is probably the same thing. See page 173.

PLATE 38



TREMELLA FUCIFORMIS. No. 1408

1408. On a fallen oak branch, Tenny's ravine, October 20, 1914. Photo.
3979. On decaying oak log, Strowd's lowgrounds, January 18, 1920.

3. Tremella frondosa Fr.

PLATES 39 AND 56

This is much the largest of our Tremellas, forming a mass up to 15 cm. in diameter, and up to 7-10 cm. high of flat, very thin, crumpled and contorted, petal-like lobes of a gelatinous but quite tough consistency like rubber; fused below into flattened and more or less extensive base which enters the wood. Surface quite smooth and, unless old, glaucous with the spores; color when fresh and not too old a rather light fleshy brown, in age becoming darker; drying to a raisin color if fresh, or to blackish if old. In drying there is much less shrinkage than in other species and the form is well retained.

Spores (of No. 4173) white, smooth, spherical to short oval. 5.5-7.7 x 6-10.5μ, a few 8.5μ wide. Basidia pear shaped, irregularly divided into four cells, 7.7-9.3 x 11-15μ, some up to 18μ.

Edible. Our nearest relative of this is *T. aspera* which may approximate it in size and color. For easily distinctive marks see under that species. Bulliard's Pl. 499, fig. 6T is good of the plant, so also is Lloyd's fig. 1195 in Myc. Notes **55**. 1918. Brefeld gives the spores of this species as spherical with a mucro, 10-12μ (l.c. p. 122). Under the name *T. foliacea* in the Curtis Herbarium are most of the large leafy Tremellas, some of which are certainly *T. frondosa*. The difference between these two species, if any, does not seem to be well established. See Gilbert's illustrations in Trans. Wis. Acad. **16**: Pl. 82, figs. 13, 14. 1910.

536. On a small oak log east of school house, October 9, 1912.
1006. On oak stump in Dr. Pratt's yard, October 4, 1908.
1372. Battle's Park, southeast of Dr. Battle's, October 17, 1914.
2456. On an oak log, swamp of Bowlin's creek, October 1, 1916.
4173. On oak wood, February 23, 1920.

4. Tremella aspera n. sp.

PLATES 40 AND 56

A good-sized plant, in our one collection about 3-5 cm. long, 2-3 cm. broad and 3-4 cm. thick, formed of flattened, much crumpled and contorted lobes which arise from more or less extensive and separated points of attachment; surface not smooth, but finely granular under a

lens; color of raisins, but much darker in age; gelatinous and rather tender.

Spores pure white, spherical with a distinctive mucro, 8.6-11.8μ. Basidia subpyriform, large, divided quite irregularly into four cells, 15.5-18.5 x 20.2-25.9μ.

There seems to be no agreement among European botanists as to what *T. foliacea* Pers. is (if indeed different from *T. frondosa*), and furthermore our plant does not agree with any of them. Bresadola's idea of *T. foliacea* is that it grows on Larix and Abies 4-8 cm. high and broad, from hyaline-saccharine to fleshy-isabelline tinted with umber-violet. Spores hyaline, globose, 7-10 x 7-9μ, basidia subglobose to ovate, 16-18 x 14-16μ. Subhymenial hyphae 2-2.5μ thick (Fung. Trident. p. 97, Pl. 209, fig. 1). This conception is evidently quite different from that of Brefeld (l.c. p. 98) who places *T. foliacea* in the genus *Ulocolla* and doubts its distinction from *U. saccharina* (previously *Exidia saccharina*) which, he says, has identical basidia, spores and sporidia, as well as color, and grows also on coniferae.

This species differs from *T. frondosa* in rougher surface that is not glaucous, larger spores and much larger basidia, more complicated, crumpling, thicker, less simple and less perfect lobes, more tender structure, and darker color. In drying *T. frondosa* shrinks very much less than *T. aspera* and does not become so black.

3950. On decaying oak stump back of Power Plant, January 17, 1920. Photo. Type.

5. **Tremella auricularia** Möller

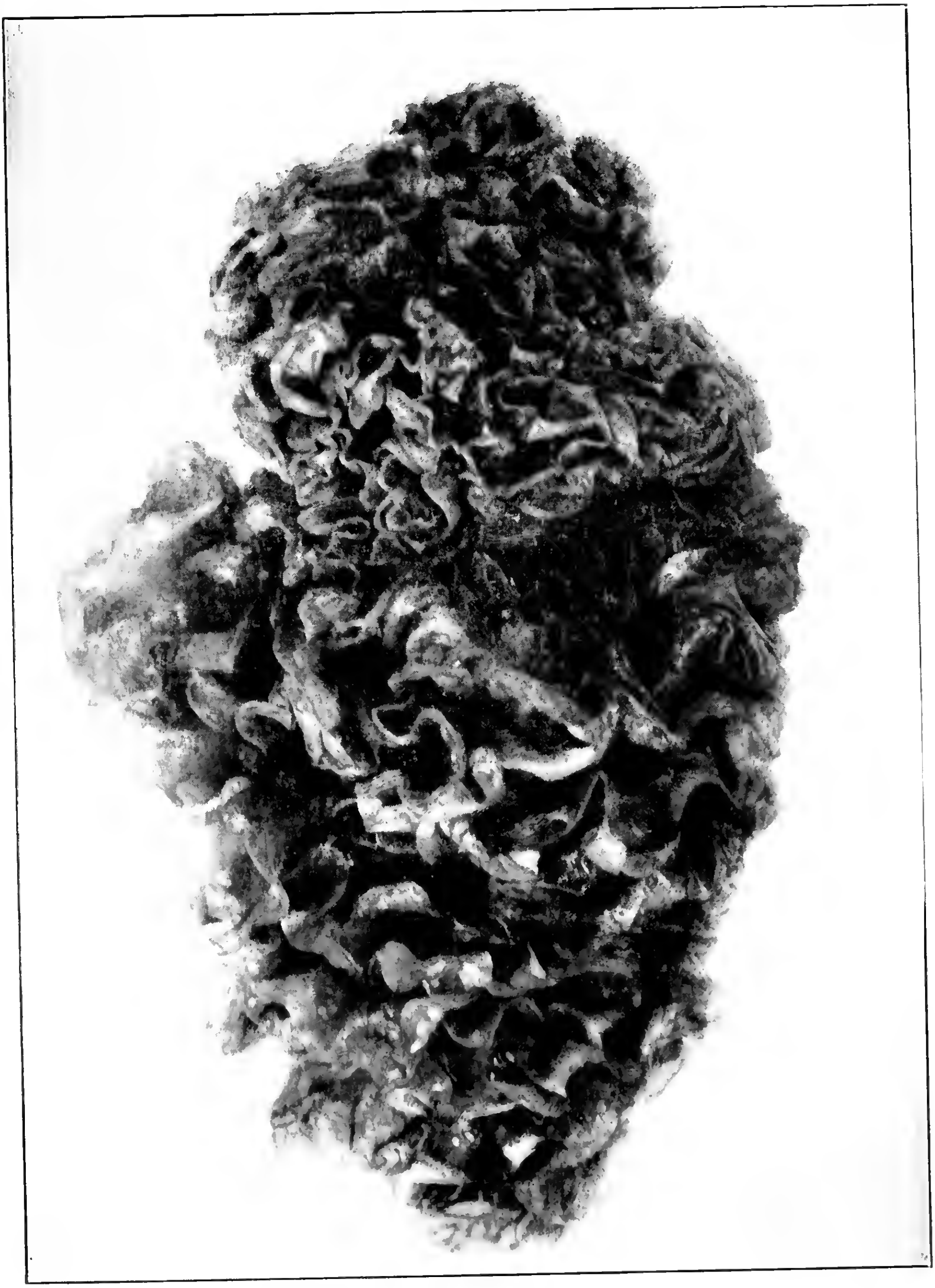
PLATE 62

Forming a flat, somewhat crumpled, folded, erect and branched plate about 1.5 cm. long and 7 mm. high and less than 1 mm. thick; color a dull reddish clay, almost intermediate between raisin color and clay color; surface smooth. Texture softly gelatinous and tender.

Spores white, elliptic or in one view approaching jug-shaped, 5.2-9.7 x 9.3-15μ, a few oval. In sprouting the spores form a good number of very small spherical sporidia about 3-5μ thick, which absorb all the contents and form a group in place of the collapsed and almost invisible spore. Basidia four-celled, 12.5-15μ thick.

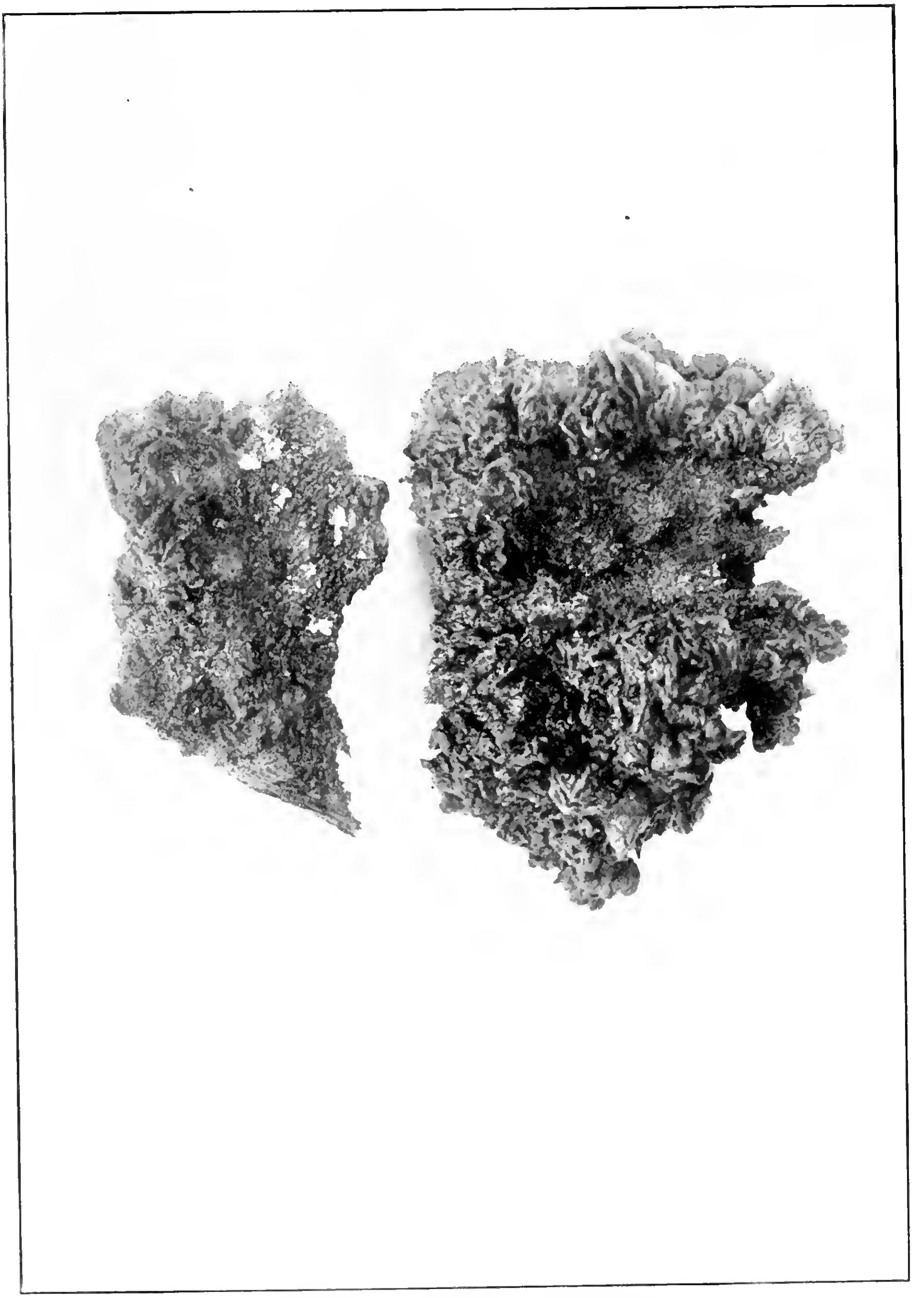
This is easily different from our other species in the white, jug-shaped spores, small size, delicate texture and dull color. That it is Möller's species seems certain. His description and figures agree,

PLATE 39



TREMELLA FRONDOSA. No. 536.

PLATE 40



TREMELLA ASPERA. No. 3950.

the spores having just the right shape and sprouting in the same quite peculiar way. The spores are said to be pear-shaped, 10-12μ thick; basidia 15μ thick (see Möller: Protobasidiomyceten, p. 170, Pl. 4, fig. 16. 1895).

4159. On privet (*L. sinense*), February 21, 1920. Drawings.

6. **Tremella lutescens** Pers.

PLATES 23, 41 AND 57

Plant forming an elevated, lobed mass with a surface of crumpled folds resembling somewhat a duodenum, many of the larger folds hollow, emerging from a small attachment and often bursting through the bark; surface not rough; breadth about 1-2.5 cm., height about 3-17 mm., surface dull, glaucous from the spores, color pale orange to clear orange, drying usually a rather darker orange and retaining much of its form. Texture firmly gelatinous, much less soft than *Exidia gelatinosa*.

Spores (of No. 3895) smooth, spherical to short-elliptic, 6.3-9 x 7-13μ, varying in size with the cells from which they spring. Basidia pear-shaped, divided into cells by longitudinal or slanting or quite irregular walls, the cells often quite unequal in size.

Easily recognized by its bright color, folded and hollow structure, medium size, glabrous surface, absence of a white membrane within and growth on deciduous wood. This seems very like *T. compacta* Möller from Brazil in form, size, color and hollow lobes, but that is said to have basidia 12-14μ thick and spores 6-7μ thick (Möller l.c. p. 107). See also Lloyd in Myc. Notes **58**:825. 1919. In the Curtis Herbarium plants labelled *T. lutescens* are mostly T. *fuciformis*. Such are plants from Hillsboro, N. C., Santee Canal, S. C., and Alabama. One so labelled from the Schweinitz Herbarium (Bethlehem) is a Dacrymyces with large eight-celled spores, 7-7.8 x 20-23μ. It looks like Curtis' Society Hill Dacrymyces which he calls *T. aurantia*, but which is not that species.

This I have decided to call *T. lutescens* rather than *T. mesenterica* although I am far from convinced that these two species are properly understood either in Europe or America, if indeed they are distinct. There are no serious discrepancies between our plant and *T. lutescens* as understood by Brefeld. His plant, contrary to the usual statement, is orange when young, paler in age. The plant is usually re-

ferred to as paler than *T. mesenterica*, whitish in youth. Brefeld states the spores as being round with a point, colorless, 12-15μ thick. He received one plant from a correspondent that he took to be *T. mesenterica*. This was distinguished from *T. lutescens* by more irregular, distally enlarged, more or less nodulated sterigmata. Spores about the same as in *T. lutescens* (10-12μ thick) but sprouting with much fewer projections than in the latter. (See also Tulasne in Ann. Sc. Nat. 1853, Pls. 10 and 11).

This is almost certainly *T. mesenterica* as understood by Schweinitz. A specimen from him in the Curtis Herbarium is like my plants, basidia oval, 12-4-15 x 17-18μ, surface of the plant smooth. Curtis' own specimens labelled *T. mesenterica* (Society Hill, S. C., No. 1407, on deciduous bark) are a Dacrymyces with eight-celled spores about 15.5-21.7μ long.

3895. On dead stem of Ligustrum, Rosemary Street, December 14, 1919.

3916. On a decaying oak limb, bursting through the bark, Battle's Park, December 21, 1919. Basidiospores pale yellow to orange yellow, ovate or subspherical, 7.4-9 x 8-11μ. Basidia oval, 13.7-15.5 x 18-20μ, divided into four cells by longitudinal or slanting walls. Conidiospores orange yellow, oval, 2.8-3.7 x 3.4-5μ.

4032. Decaying maple wood on Strowd's hill, January 25, 1920.

4069. On a fallen branch of Spanish oak, February 4, 1920. Spores short-elliptic, 7.4-10 x 9.3-14.8μ. Basidia oval, 14.8-16.6x16-20μ.

4108. On oak bark by Battle's branch, February 13, 1920. Hollow in part, deep orange when young.

4204. On dead oak in Tenny's ravine, March 13, 1920. Lobes hollow. Spores short-oval, 7-8.5 x 9.3-12.5μ. Many secondary ones of various sizes. Basidia oval, young ones pear-shaped, irregularly divided, 11.2-15.5 x 14-20μ.

7. **Tremella pinicola** Britz.

PLATES 41 AND 58

Orange-yellow, composed of a few thin, flat, crumpled lobes or more folded and less plate-like, not hollow, making a clump 2.5 x 1.2 cm., and 7-10 mm. high, which is pinched at the base and attached by a line; not rooted; lobes when distinct about 1 mm. thick, surface nearly or quite glabrous. Texture firmly gelatinous; flesh translucent about color of surface.

Sporidia oval or elliptic, orange-yellow, 1-2.5 x 3-5μ. Basidia subspherical to oval, 16.5-18.5 x 20-23μ, irregularly divided into four cells. Basidiospores subspherical, 10-11 x 11-12.2μ.

PLATE 41

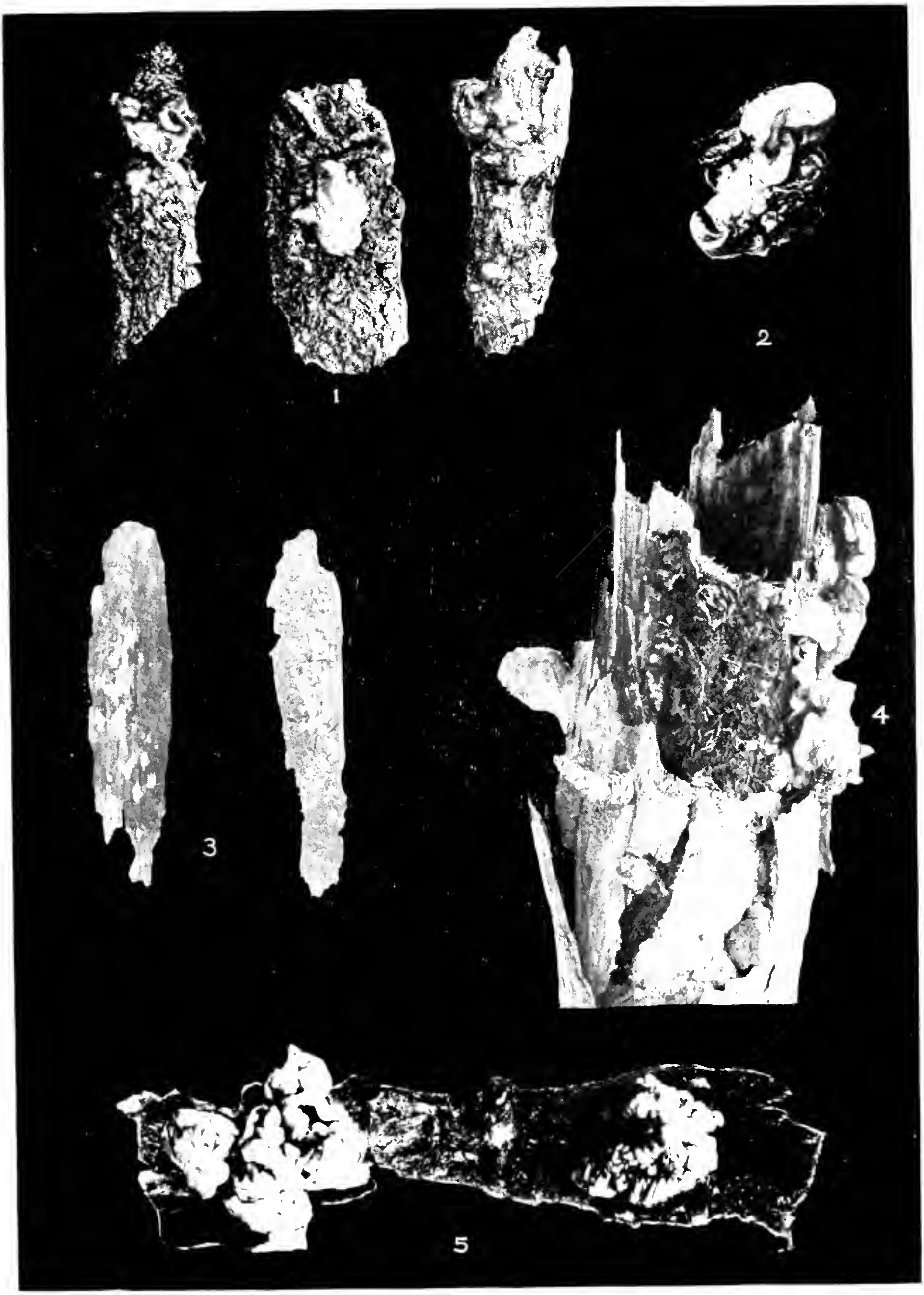


FIG. 1. NAEMATELIA NUCLEATA. No. 4046.
FIG. 2. TREMELLA PINICOLA. No. 4050.
FIG. 3. PLATYGLOEA LAGERSTROEMIA. No. 4062.
FIG. 4. DACRYMYCES PEDUNCULATUS. No. 4185.
FIG. 5. TREMELLA LUTESCENS. No. 3895.

We refer this to *T. pinicola* Britz. because it is about the same color and size, grows on pine and has similar spores. There is nothing else at all like these on pine and it seems best to interpret it in this way at present rather than to make a new species. Only microscopic comparison with the type, if any exists, can make the determination sure. Britzelmayr's description of his species is as follows (translation): "Gelatinous, externally orange, inside clearer, sessile or with a short stalk, surface with small undulations and pits, in other respects, including the spores, similar to *T. mesenterica*; on the bark of pine, fir and larch throughout the year." (Bot. Centralb. **54**:104. 1893). I have not seen his fig. 19 in his Tremellini fascicle as it is missing in the copy at the New York Botanical Garden. *Tremella pinicola* Pk. was published earlier and would take precedence, but it is not a Tremella. (See note on p. 150).

This cannot be *T. rufolutea* from Cuba. In the Curtis Herbarium is a specimen labelled *T. rufolutea* from Cuba (Wright, No. 217). It is a resin-colored mass of considerable size, apparently solid and amorphous. It is certainly not a Tremella. (See note by Lloyd under *T. compacta* in Myc. Notes **58**:825. 1919.) No basidia could be obtained from it. Massee's notes on *T. rufolutea* seem to refer to an entirely different plant (Jour. Myc. **6**:183. 1890). It resembles most *Naematelia quercina* (No. 3935) in form and color, basidia and spores, but differs in absence of the internal white membranes and different surface. *Tremella lutescens* (No. 3895) is also very similar in form and color, but differs in the smaller spores, smaller and more elongated basidia and hollow sacs. Both differ also in growing on deciduous wood. The lobes of the present species (No. 4050) are more like folded plates (as in *T. frondosa* but to a less degree) than in the other two. *Tremella spectabilis* Möller from Brazil is of somewhat similar form and color, but has basidia 13-15μ thick and spores 5-6 x 10μ, and probably grows on deciduous wood (kind not stated) (Möller, l.c. p. 122).

Hartsville, S. C. On bark of *Pinus taeda*, December 25, 1919, (No. 4050). Coker.

8. **Tremella virens** Schw.

PLATES 23 AND 57

Forming pulpy, much convoluted, irregular, flattened, compound masses which may extend along the branch-like *Exidia glandulosa* for

a distance of 15 cm.; individual plates are centrally attached and spread out flat on the bark, about 5-10 mm. broad and 1.5-2 mm. thick except where crumpled by pressure, then at times up to 6 cm. high, with much the habit of larger masses of Naematelia; at first firmly gelatinous then softer on exposure; color amber to pale amber, with a faint olive tint, later with brownish red tints in parts; not rooting; surface glabrous, not glaucous.

Spores (of No. 4070) elliptic, smooth, light greenish-yellow under microscope, 6-7.4 x 9.3-12.9μ. Basidia oval, 12.5-14 x 15-16μ, four-parted.

That this is *T. virens* seems certain. It is different from anything else we have, grows on dogwood and, in large groups, always shows a distinctly greenish tint. It is not confined to dogwood, but is also found on oak. *Tremella virescens* Schumacher (Enum. Plant. Sæll. 2:439. 1803) does not seem very different as understood by Brefeld. He was confused on the name of the last and treats it as "*T. virescens* n. sp. formerly *Naematelia virescens* Schm." (Brefeld l.c. p. 128, Pl. 8, figs. 25-28). *Naematelia virescens* (Schm.) Corda is supposed to be the same, but Corda speaks of the inside veined with white and figures the center pale (Icon. Fung. **3**:35, Pl. 6, fig. 90. 1839). The spores of *T. virescens* are given by Lindau as ovate, 12-15μ long; basidia olive green, 15-20μ thick (Krypt. Fl. Mark Brand. **5***a*:920. 1914).

4070. On rotting dogwood branch with bark on, February 4, 1920. Photo.

4153. On dead dogwood limb, February 22, 1920. Basidia oval, about 13-14μ thick.

4161. On decaying oak limb, February 22, 1920. Spores elliptic, smooth, pale greenish-yellow under microscope, 5.5-7.4 x 9-13μ.

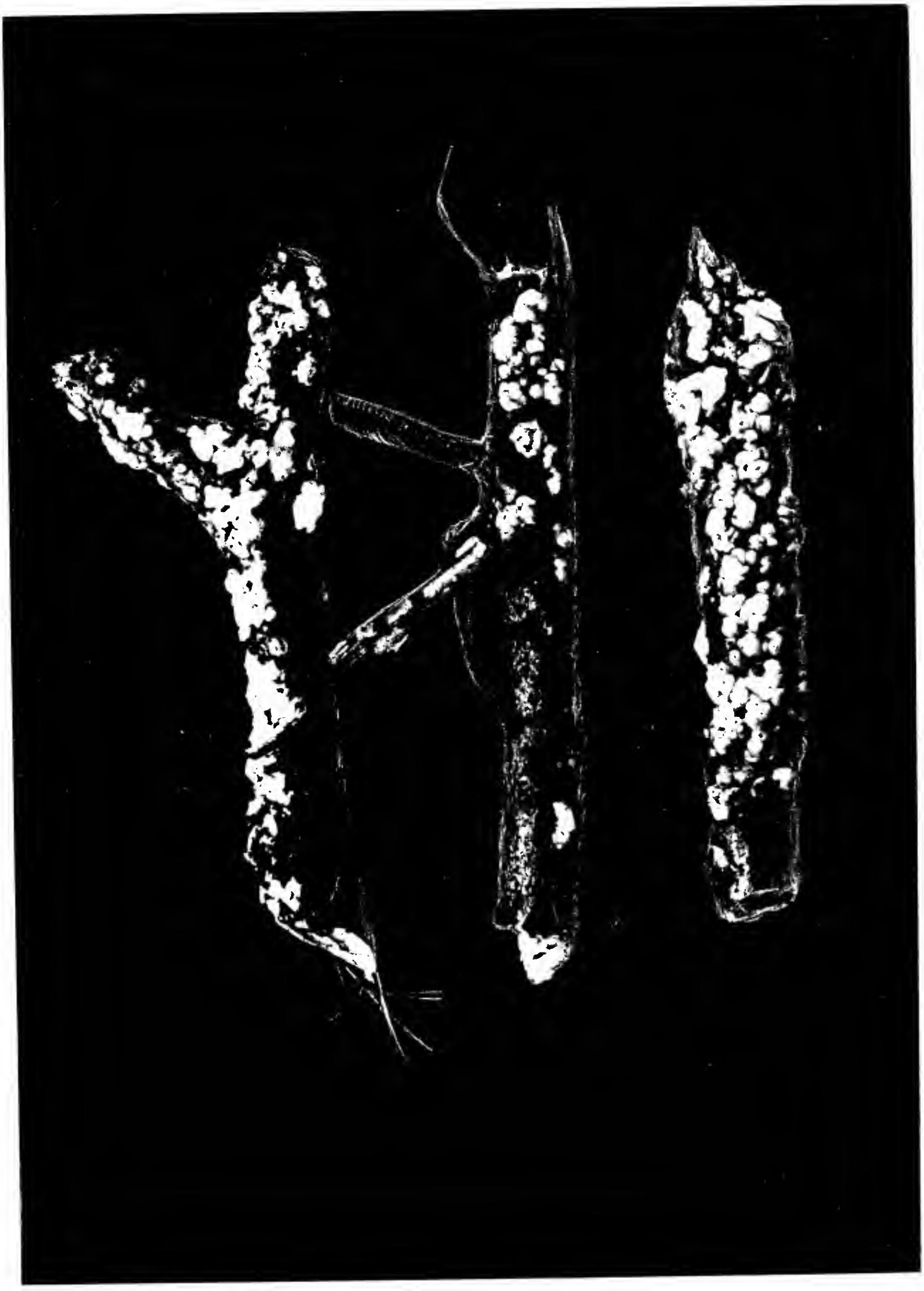
4172. On dead oak limbs, February 23, 1920. Plants pale greenish amber, extending 2.5 x 15 cm. Spores subspherical to elliptic, smooth, 5.5-7.4 x 7.5-12μ, pale greenish amber under microscope.

9. **Tremella carneoalba** n. sp.

PLATES 23, 42 AND 59

Plant forming small, convoluted, flattened pustules which touch and crowd each other over considerable areas or in part may be only gregarious. Individual pustules about 1-8 mm. broad and up to 4 mm. high, wet but not viscid; color pallid white to creamy yellow and often with a distinct flesh tint so as to be more flesh color than yellow; texture firmly gelatinous.

PLATE 42



TREMELLA CARNEOALBA. No. 5877.

Spores white, spherical, variable in size, 6.3-10.2μ in diameter, smooth, sprouting soon in water to a short promycelium with an apical spore of the same shape and a little smaller. Basidia spherical to very short-oval, 14-16μ in diameter, four-celled by longitudinal walls, which are median or eccentric and often oblique, the cells often of different sizes and producing spores in proportion. Sterigmata long to very long, irregular, pointed, collapsing as well as the basidial cells as soon as the basidiospore is formed.

Distinguished by the small size, pale color and pulvinate form. The plant dries down to very inconspicuous amber-colored crusts with a thin, superficial dusting of white fibers. It revives to the original form on wetting again.

This cannot be *T. viscosa*, for that has elongated, sausage-shaped spores according to Berkeley (Ann. & Mag. Nat. Hist. 13:Pl. 15, fig. 4) and Patouillard (Tab. Analyt. No. 475). Britzelmayr gives the spores of *T. viscosa* as 5-6 x 10-12μ, but Schroeter gives them as subglobose, 11-13 x 15-17μ (see Saccardo). This looks like a confusion of species. The illustration in Flora Danica showing habit (Pl. 1851, as *Thelephora viscosa*) is very much like our plant. *Tremella candida* var. *effusa* Alb. and Schw. can hardly be this, as it is said to be ½ inch thick. If it were not for its growth on wood this could hardly be distinguished from *Sebacina caesia* Tul. as illustrated by Patouillard (Tab. Analyt. No. 681). That is said to grow on the ground. The habit sketches are almost exactly like our plant and the subspherical spores (8 x 10-12μ) sprout to a single spore of similar shape. *Exidia albida*, as illustrated in Massee's British Fungi and Lichens, Pl. 30, fig. 1, is an exact representation of our plant, even the pinkish tint being shown, but all the published spore measurements of that species agree in giving them an elongated, sausage-shape (see also notes under *T. fuciformis*).

Exidia guttata Bref. is also very similar in form and color, but is a true Exidia with the curved spores 4 x 10μ. *Tremella globulus* Bref. is small, brownish and pulvinate, but could not be this as the spores are 15-18μ in diameter. The hymenium is brownish, the inner part colorless (?) ("Weiss") (Bref. l.c. p. 126).

3877. On fallen branch of Carpinus in Arboretum, December 12, 1919. Photo. Type.

4020. On twigs of privet on the bush in President's yard, January 24, 1920. Typical *Exidia glandulosa* was abundant on the same twig and crowded the Tremella in places.

4022. On Robinia twigs on tree, January 24, 1920. Color watery milk with a faint pink tint. Spores 7-9.7μ in diameter, spherical (spore print on slide), many budding and sending out promycelia to form a spore of the same shape on the end just as in No. 3877.

10. **Tremella subanomala** n. sp.

Plate 58

Pulvinate, convoluted, forming an apparently compound tuft 4 x 6 mm. and about 1.5 mm. thick; color pallid brown to wine-brown; the surface appearing minutely granular under a lens; texture very firmly gelatinous, harder than any other species; bursting through the bark.

Spores subspherical, remarkable in being compressed a little at right angles to the mucro, 7.4-10μ in diameter, a few up to 11μ. Basidia subspherical, a few oval or pyriform, not collapsing when emptied, four-celled by longitudinal divisions, 13-17μ thick.

This is like a plant on alder labelled *T. bulgaroides* E. & E. from Canada (Macoun) at the New York Botanical Garden, but I cannot find that this name was ever published. It is nearest *Tremella carneoalba* which differs in pinkish-white color, more gregarious growth, and basidia that collapse after forming spores. It is not unlike *T. anomala* Möller (l.c. p. 120) in size, form, and color (up to 0.5 x 1.5 cm.; color smoky-yellow), but that has basidia 10μ thick and spores 6μ thick.

4005. Dead Alnus twigs by Battle's branch, growing with Cyphella, January 22, 1920. Type.

11. **Tremella moriformis** Smith.

T. colorata Pk.

This has so far not been reported from North Carolina (except by Curtis as *D. moriformis*, probably from the S. C. collection by Ravenel), but it almost certainly occurs in the state and should be looked for. I have prepared the following description from the good type specimens of *T. colorata* Pk., from a collection of *T. moriformis* from Bresadola (on Robinia from the Trentino) and from a collection from South Carolina in the Curtis Herbarium (Ravenel). See Sowerby's English Botany **36**:2446. 1812.

Plant forming irregular, more or less anastomosing, pulvinate patches extending more or less densely for several cms. on the wood,

individual patches tending to take an elliptic form like half of a football. Surface granular and irregular, not typically convoluted; the outer layer nearly black, quite tough and forming a kind of crust; the inner tissue more gelatinous and a lighter purple under the microscope; hyphal threads with numerous clamp connections, each thread distinctly purplish. Basidia near the surface, subspherical to oval, 12-14.5μ thick, colorless when young, purple when mature, divided often irregularly into four cells. Spores said by Peck to be color of hymenium when mature, globose, 12.7-17.7μ in diameter. His figures are evidently wrong, and he probably took the younger basidia for spores. We have not been able to be sure of the spores in any of the herbarium specimens examined. Spore-like material present was badly mixed and much collapsed.

If a true Tremella, this species is evidently an aberrant one. It is easily recognized by the blackish-purple color, practically black in herbarium specimens except under the microscope.

We include the following notes for the convenience of students:

Tremella tremelloides (Berk.) Mass. (*Sparassis tremelloides* Berk.). The following is adapted from Massee (Jour. Myc. 5:184, Pl.14, fig. 1. 1889). Tremelloid, lobes fasciculate, elongated, suberect, almost free to the base or variously united, compressed, springing from a small contracted base, surface scabrid, dull orange; spores elliptic-oblong with a minute oblique apiculus at the base, 11-12 x 5μ. On wood, Lower Carolina (Type in Herb. Berk., Kew). Forming large tremelloid tufts, always springing from a very small basal portion which penetrates the matrix; lobes suberect, 3-4 inches high in well grown specimens, sometimes smaller, in some specimens variously plicate and almost free to the base; in others the lobes are united laterally and form a gyrose tuft, always much compressed. The distinctly scabrid surface is very characteristic, and is due to thickly scattered papillae, which give a very harsh feel to dry specimens. Basidia large, sterigmata developed in succession. From Massee's figure of the spores this is probably an Exidia.

Tremella gigantea B. & Cooke, is, according to Massee, a gelatinous lichen (Jour. *Myc.* 6: 182. 1890).

Tremella rufolutea B. & C. See my note under *T. pinicola*, also see Massee (Jour. Myc. 6: 183. 1890).

Tremella enata B. & C. is represented in the Curtis Herbarium by No. 2456 on oak from Society Hill, S. C., a number mentioned in the original description. On examining it I found nothing to indicate that it is either a Tremella or a Dacrymyces. It is apparently not related to either. Massee, however, has studied the other number mentioned in the original description, No. 4307, at

Kew, and thinks it a Dacrymyces. We adapt the following from his description: (Jour. Myc. 6:182, Pl.7, figs. 14-17. 1890): Erumpent; dark amber, appressed, surface slightly rugulose, or almost smooth, bounded by the ruptured bark, up to 1 centimeter diameter; basidia cylindrical, bifurcate at the apex, 45-50 x 5μ; spores elliptic-oblong, colorless, with an oblique apiculus at the base, slightly curved, 10-11 x 3.5μ. Superficially resembling a small discolored form of *Tremella albida*, but a true Dacrymyces. From 3 millimetres to 1 centimetre across. On *Alnus serrulata* and oak, Lower Carolina.

Tremella myricae Berk. & Cooke. The following is adapted from Massee (Jour. Myc. 6: 182. 1890): Foliaceo-gyrose, gelatinoso-elastic, semi-pellucid, smoky gray, when dry blackish with a tinge of purple here and there, surface with minute, scattered points; spores broadly elliptic, with an oblique apiculus, 8-9 x 6-7μ, colorless. Forming thin, foliaceous expansions when dry, 1-4 centimeters across. The minutely scabrid surface when dry is characteristic. On bark of Myrica and Persea, Gainesville, Fla. (Rav.).

Tremella dependens B. & C. The following is from Massee (Jour. Myc. 6: 183. 1890): Pendulous, elongato-clavate, attached by a slender stem-like base, mucilaginous, pale dingy yellow, the central portion consisting of exceedingly thin hyphae immersed in mucilage; towards the even surface the hyphae become thicker and form a compact layer which produces basidia at every part of the surface; basidia spherical with four elongated sterigmata; spores elliptic-oblong, smooth, colorless, 7 x 3-3.5μ. Hanging down from underside of rotten poplar (Liriodendron) logs after rain, Alabama. Peters.

Tremella stippitata Pk. (Rep. 27; 100. 1875) is a Coryne. He also reports *T. enata* B. & C. (l. c. p. 100).

Phaeotremella pseudofoliacea Rea. (Trans. Brit. Myc. Soc. 3:377. 1912). This genus is based apparently only on the umbrinous spores (which are obovate, 12 x 9-12μ). The plant looks much like our *Naematelia quercina* in external form, and the spores are about the same.

Exidia scutellaeforme B. & C. In the Curtis Herbarium is a specimen of this from Alabama (Peters No. 1093: Curtis No. 6343. Type?) The dried plants are black and look like *E. glandulosa*. In Dr. Farlow's writing is the note: "Basidia are vertically 4-parted."

Exidia pinicola (Pk) (Rep. 39, p. 44. 1886 as Tremella). Peck's description is: "Pulvinate, gyrose-plicate, somewhat lobed and lacunose, raisin-colored when moist, blackish when dry, filaments slender, branched; spores oblong, curved, colorless, .0005 in. long, .0002 broad. Dead branches of pine, July."

We have examined the type and find the color as described; basidia oval or pear-shaped, 4-parted, 9.3-10.3μ thick; spores curved-elliptic, smooth, 3.7-4 x 9.5-11.1μ. This evidently throws the plant into the genus Exidia, and it seems nearest *E. gelatinosa*. The surface appearance is that of a crowded colony of very small individuals of *E. gelatinosa*, and is not at all cerebriform. It may be easily recognized by the raisin-color, small flat plates around sunken chambers and growth on pine. The texture is toughly gelatinous. It may well be that this is the same as *E.umbrinella* Bres. which grows on conifers, is said to be near *E. recisa*, and has spores 3-4 x 11-14μ, basidia 8-9 x 10-12μ (Fung. Trident. 2:98. Pl. 209, fig. 2. 1900).

The following are translations of Schweinitz's original descriptions of species of Exidia and Tremella with notes added by us:

Exidia lurida Schw. (No. 1100. Syn. Fung. Amer. Bor p: 185: 1832) "Effused gyrose-plicate, pale, circular; rather thick. Shrunken on drying. Dotted over with a few papillae. It occurs here and there on branches of *Celastrus*, Bethlehem." A plant in the Schweinitz Herbarium has the general aspect of *E. gelatinosa* but seems different in the absence of scurfy particles. A preparation showed basidia of the Exidia type.

Exidia spiculata Schw. (No. 1101. Syn. Fung. Amer. Bor. p. 185:) "Adpressed, effused, thick-lobed, rough, wrinkled, olivaceous-green, very slightly shrunken on drying, but black in color. Papillae frequent on the upper side; margin divided into small obtuse lobes. Rather rare on the cut surface of trunks of *Platanus*, Bethlehem." On examination the type showed no papillae when wet: dark, effused, crumpled, extensive. Not shrunken to a membrane. A slide revealed no facts of value.

Exidia applanata Schw. (No. 1102. Syn. Fung. Amer. Bor. p. 185.) "Applanate-expanded, closely adpressed, margin at length subfree, oblong in shape, moderately thick, 2-3 lines long; drying black and somewhat pulverulent-scurfy; marked on the surface with a few wrinkles or veins. Papillae scattered. On the inner bark of *Rhus glabra*, Bethlehem." This may be *E. glandulosa* but a slide from the type showed no characters of value.

Tremella crenata Schw. (No. 1141. Syn. Fung. Car. Sup. p. 89: 1822). "Rather large, thick, wavy-applanate, ribbed, fuscous brown; margin beautifully crenate. Occasional on branches." This is *E. gelatinosa*.

Tremella crassiloba Schw. (No. 1112. Syn. Fung. Amer. Bor. p. 185.) "Erumpent, firm, with thick, fleshy-tremellose, rounded white lobes forming a globose mass. In the wet state, surface apparently squamulose; when dry, black and pulverulent. Bursting forth from fallen branches, Bethlehem." A specimen in the Schweinitz Herbarium shows low, black, pulvinate, somewhat uneven warts about 1-1.5 mm. broad, coming through small holes in the bark of deciduous branches; when wet becoming murky clay-color and gelatinous, about consistency of *Exidia glandulosa* but does not seem to be that or *E. recisa.* There are no papillae and the surface is not obviously granulose. Basidia subspherical, 4-celled, 11-13μ in diameter.

Tremella corrugata Schw. (No. 1113. Syn. Fung. Amer. Bor. p. 185.) "Cespitose, corrugated, with rather thin, flabby lobes, margin elevated, veiny; blackish-purple in color. Sub-squamulose in the dry state. An inch in diameter. Rare on wood and branches, Bethlehem." This is *Exidia gelatinosa.*

Tremella palmata Schw. (No. 1117. Syn. Fung. Amer. Bor. p. 186.) "Rooted, penetrating the wood with a tomentose root. Stem compressed; palmately expanded, horny when dry, of elegant golden color, sub-diaphanous, apex capitulate, gyrose-plicate, compressed and dilated; the head confluent with the stem. In form and habit related to *Cantharellus spathularia*, n. 292, on dead wood, Bethlehem." This looks much like *Ditiola radicata* from the specimen in the Schweinitz Herbarium, but I could get very little from a preparation made from it.

TREMELLODON

Plants gelatinous, translucent, whitish to light or dark-brown, more or less stalked, the top expanded and bent over, with short teeth on the underside. Basidia longitudinally divided into four parts with four sterigmata. Spores smooth, white, spherical. We have but one species which when large would be taken at first sight for a Hydnum except for the gelatinous texture.

Tremellodon gelatinosum (Scop.) Pers.

PLATES 43 AND 59

Plants upright, petaloid and bent over at top to form a one-sided cap under which the small spines hang down; height from 2-7 cm., breadth at top up to 7 cm., at base about 1.5-2.5 cm.; color of cap surface usually from light to dark brown, in drying becoming darker and blackish in places; rarely the whole plant may be a pure soaked white, in age the upper part becoming a light pinkish buff; in darker plants the brown may be slightly tinted with blue or violet; surface, except spines, covered with minute papillae with some wrinkles on the posterior side near the base. Flesh gelatinous, watery and translucent, but firm and tough.

Spines gelatinous, white, confined to the underside of the cap, up to 2.5 mm. long, the spores being borne only on their proximal half or two-thirds. No spores are borne except on the spines.

Basidia short, pear-shaped, 10.3μ in diameter with four stout sterigmata. Spores white, spherical, about 6.5μ in diameter.

This is a remarkable and interesting plant, having the spines of a Hydnum and the texture and basidia of a Tremella. It is found on decaying pine and is rare. It is said by McIlvaine to be edible and delicious when slowly stewed. For illustrations in color, see Schaeffer, Pl. 144; Krombholz, Pl. 50, figs. 18-22; Richon & Roze, Pl. 65, figs. 12-17; Gillet, Pl. 661 (124). See note in Mycologia **12**: 142. 1920.

912. On a pine log, October 11, 1913. Photo and drawings.

2954. From inside decaying pine stump, woods south of athletic field, December 1, 1917. Photo.

2956. From side decaying pine stump, Strowd's pasture by Bowlin's Creek, December 3, 1917.

4034. On pine log on Strowd's hill, January 25, 1920.

4092. On pine log back of athletic field, February 8, 1920.

PLATE 15

TREMELLODON GELATINOSUM. No. 2951.

TREMELLODENDRON

A remarkable genus, growing on the ground in woods and resembling stipitate species of Thelephora in habit, form and texture, but with the basidia divided into four parts by longitudinal septa, as in the Tremellaceae, and having the spores smooth, white and elongated. The genus was established by Atkinson (Journal Mycology 8:106. 1902), and the species have been treated by Burt (Ann. Mo. Bot. Gard. 2:731. 1915).

Key to the Species

Plant whitish, much branched, the stems or branches or both fusing where coming together.
- Stout and often large and heavy .... *T. candidum* (1)
- Delicate, the branches slender and numerous .... *T. merismatoides* (2)

Plant whitish, slender, little branched, the stems single and not fused with others .... *T. Cladonia* (3)

Plant simple, orange colored .... *T. aurantium* (4)

1. **Tremellodendron candidum** (Schw.) Atk.

Plates 44 and 59

Plant upright, centrally stalked, densely branched, the clumps reaching a diameter of 8 cm. and a height of 6 cm., but usually much smaller. The base is a fused mass which soon branches into more or less distinct, but often confluent upright stalks which subdivide into more or less flat and often laterally fused branches, these terminate in fibrous or decidedly fimbriated, bluntish tips, which are nearly or quite white, the remainder of the plant being a creamy or sordid white. The texture is very tough, almost woody below and is not at all brittle.

Basidia four-celled by longitudinal septa; spores (of No. 1385) white, elliptic, with mucro, smooth, with large or small oil drops, very oily as seen by the many oil drops in the water, 4.8-6.6 x 8.5-13μ.

A very abundant plant in woods and lawns and very variable in size and stoutness.

Burt recognizes *T. pallidum* as the larger, more solid forms I here include under *T. candidum*. I cannot see good grounds for recognizing more than two species here. We have many intermediate forms and sizes. I am also not sure that *T. merismatoides* is different, but am including it as a convenient name for the most delicate, Pterula-like form.

352. Mixed woods, damp low place, growing on ground, October 20, 1910.
648. On hillside east of Howell's branch, October 29, 1912.
695. In mossy grass in middle of campus, June 15, 1913.
1385. In old Raleigh road, just north of Piney Prospect, October 19, 1914. Photo.
1386. By Battle's branch, September 25, 1913.
2245. Forming a partial fairy ring of very fine plants, swamp of New Hope Creek, below Durham-Chapel Hill bridge, June 24, 1916.
2420. Deciduous woods, Battle's Park, July 22, 1916. Spores 4.5-6 x 7.7-11.1μ. These are typical, stout, large plants.

North Carolina. Schweinitz.
North Carolina. Atkinson.

2. **Tremellodendron merismatoides** (Schw.) Burt.

PLATE 45

Plant 2.5-3.8 cm. high, in compound clusters about 2-3 cm. broad above, with several partly fused stalks and very many delicate, only slightly fused branches; white and tough.

Spores (of No. 2324) smooth, elliptic, some bent, 4.8-6.6 x 7.4-11μ.

The more delicate forms of *T. candidum* approach this, but we have found none close enough to it to make a complete gradation and it may be a good species, as considered by Burt. The spores are exactly like those of *T. candidum* in appearance; in our one collection they run a little shorter than in No. 1385, but no shorter than in No. 2420, which are typical large plants.

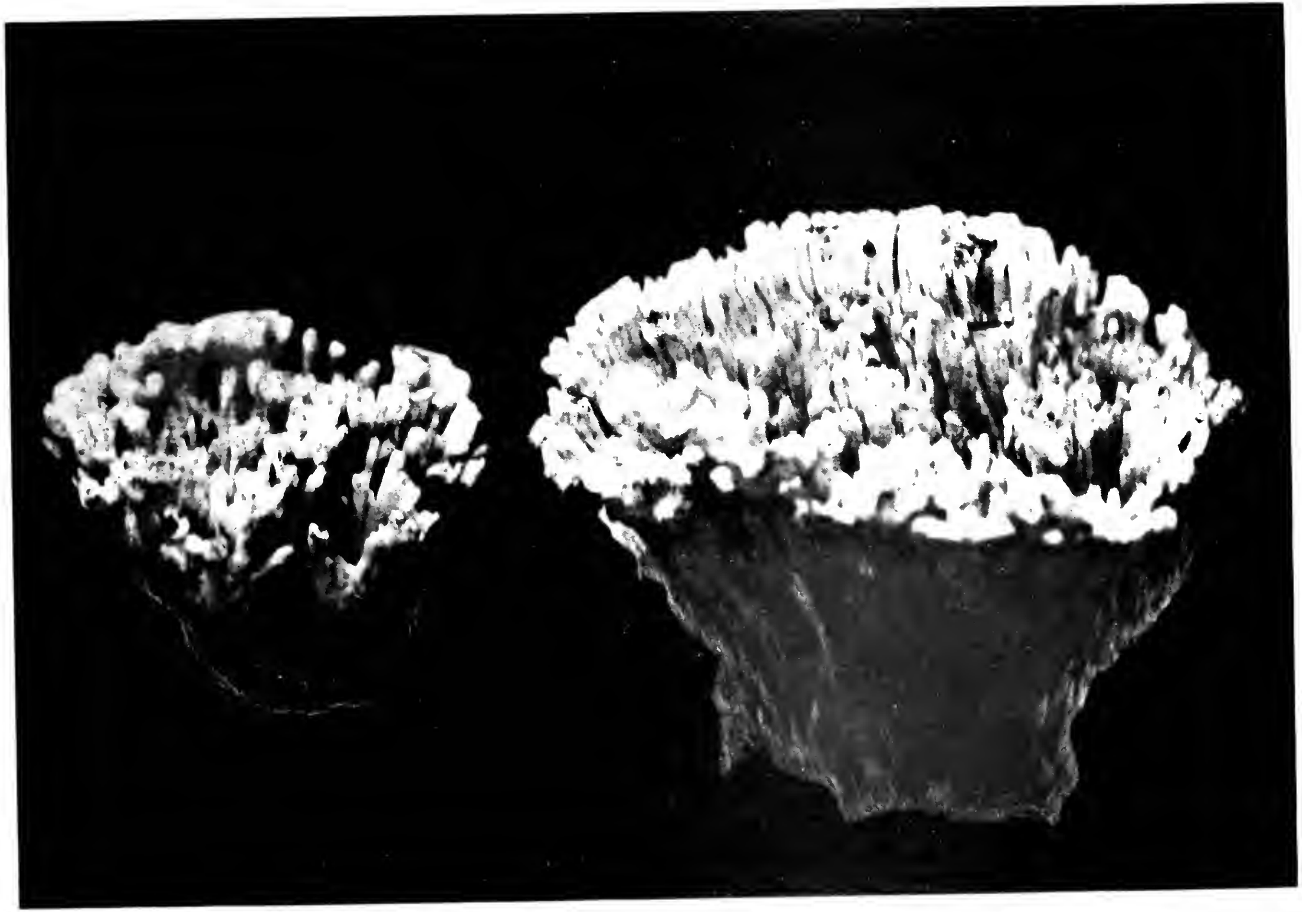
2324. In sandy humus, deciduous woods by western branch of Meeting of the Waters, June 30, 1916. Photo.

3. **Tremellodendron Cladonia** (Schw.) Burt.

We have not found this and adapt the following from Burt (l.c. 2:738. 1915):

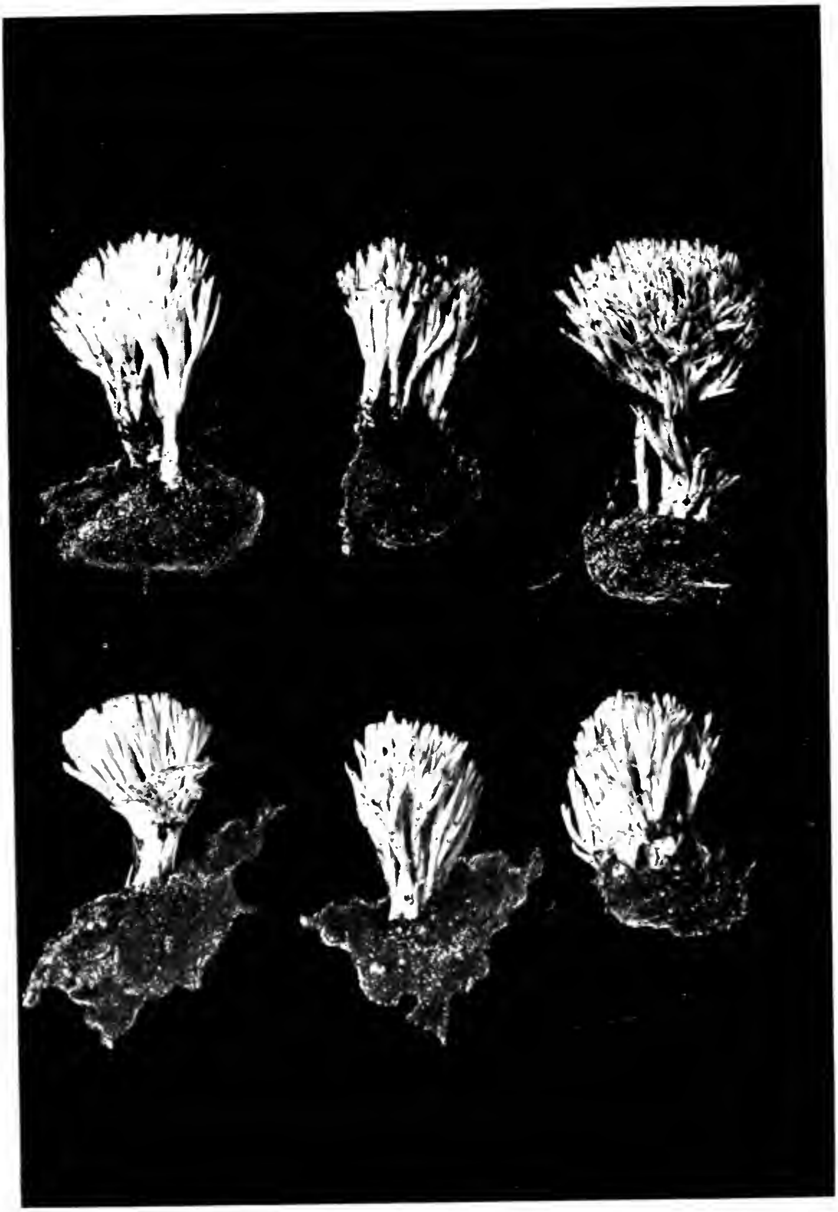
Plant 2.5-5 cm. high, 0.7-2 cm. broad; stem about 1.5 mm. thick; solitary or gregarious, erect, coriaceous-soft, pallid, drying warm buff, sometimes with the older portions pale olive-gray, stipitate; stem cylindric, palmately branched into a few—often three—cylindric branches, each or some of which occasionally branch again in similar manner; branches arranged in a plane from flattened end of stem or branch or in a circle about the cylindric end of the stem which is then sometimes perforate and the branches often channelled; hymenium amphigenous, or inferior when the branch is channelled; basidia

PLATE 11



TREMELLODENDRON CANDIDUM. No. 1385.

PLATE 45



TREMELLODENDRON MERISMATOIDES. No. [illegible]

longitudinally septate, pyriform, 9 x 15μ; spores colorless, simple, even, curved, 4.5-6 x 9-15μ. On ground in woods. Canada to Mississippi and westward to Missouri. August and September.

Blowing Rock. Atkinson.
North Carolina. Schweinitz.

4. **Tremellodendron aurantium** Atk.

This was described from Blowing Rock, N. C., by Atkinson and has not been found since. We give below the original description (Ann. Mycologici **6**:59. 1908):

"Plants simple, slender, 1-3 cm. long 2-3 mm. stout, dark orange, tough. Basidia subglobose, 10-12μ, longitudinally divided; sterigmata 4, long, slender, flexuous. Spores, oboval-subelliptical, granular, then with an oil drop, 7-10 x 5-6μ, white, hyaline."

Blowing Rock. Atkinson.

EICHLERIELLA

Plant forming small, adherent patches with the margin free and often a little bracketed, rarely attached only by the center; texture tought, coriaceous or leathery, dry or rarely waxy. Basidia ovate, divided into four cells by longitudinal divisions. Spores long, curved, smooth, white. The genus resembles Corticium or Stereum or Cyphella except for the four-celled, ovate basidia. We have but one species, the only one recorded from this state. See Burt, Ann. Mo. Bot. Gard. **2**:743. 1915.

Eichleriella Leveilliana (B. & C.) Burt.
Corticium Leveillianum B. & C.
Stereum Leveillianum B. & C.

PLATES 46 AND 59

Plant forming subcircular, mostly resupinate patches about 3.7 mm. wide, with a narrow, free margin which may curve outward on the upper side for about 1-1.5 mm. if the substratum is vertical; dorsal surface of the shelving margin tomentose, nearly white to light or dark gray depending on exposure, scarcely zonate. Hymenium a clear, light rosy pink, fading to nearly white in areas or all over when old. The thickish, blunt margin is sharply determinate, and tends to

become somewhat free all around. Texture leathery and pliable, not brittle when dry. In this lot of numerous patches one plant, emerging from a lenticel, was attached by only a point eccentrically placed, all the rest of the cap being free. When young the plant appears as a little peltate disc, but this soon expands and except for the free margin attaches itself to the bark as it grows.

Basidia like those of a Tremella, ovate, four-celled by longitudinal divisions, 9.3 x 18μ, sterigmata long. Slender branched threads grow up densely beyond the basidia to form the hymenial surface. Spores white, smooth, bent, sausage-shaped, 4-5.5 x 12.5-17.3μ.

This is a remarkable plant and was first described from South Carolina as a Corticium. It would be referred at once to Corticium or Stereum if it were not for the peculiar basidia. The pretty, delicate rosy color is preserved in drying.

3829. On sweet gum (Liquidamber) twigs, back of Peabody Building. December 6, 1919. Photo.

3953. On frondose twigs on grape arbor, January 17, 1920.

SEBACINA

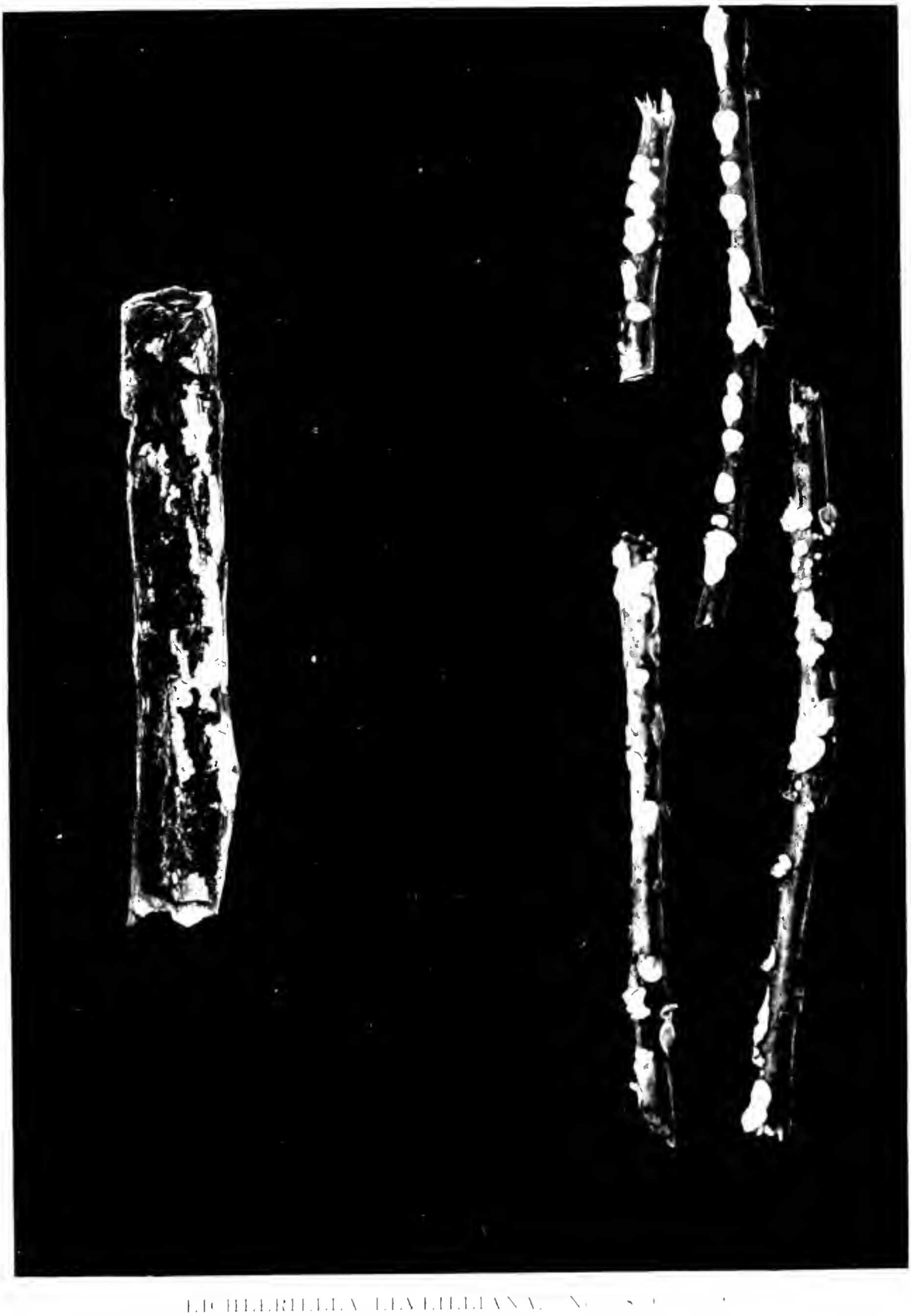
Resupinate, on bark or wood as in Corticium or encrusting herbaceous stems or mossy tree bases from the ground; texture various, waxy to leathery or coriaceous; basidia ovate and longitudinally septate as in Tremella; spores white, smooth, mostly enlongated and bent or flattened on one side (in *S. cenerea* Bres. they are said by Bresadola to be subglobose, 12-13 x 12-15μ, in *S. caesia* Tul. they are given by Patouillard (Tab. Analyt. No. 681) as ovoid, 8 x 10-12μ). We have found four species in Chapel Hill and two others are reported from the state. See Burt. Ann. Mo. Bot. Gard. 2:749. 1915. Of the four species we have found only one can be distinguished in Burt's monograph. We have tried to determine the other three from the European literature, but not having been able to do so as yet have decided to let them go unnamed until we become more familiar with the genus. Burt has seen our plants, but has not cared to give a positive opinion from the material sent. All our figures are from fresh material and the spore characters taken from good spore prints.

KEY TO THE SPECIES

Diffused as a thin or thickish crust on dead wood, with the habit of a Corticium.

Plant up to 1 or 1.5 mm. thick; spores 6.3-9 x 7.7-12.2μ .... *S.* sp. (No. 4116) (2)

PLATE 46



EICHLERIELLA LEVEILLEANA. No. [illegible]

SEBACINA CALCEA. No. 3963 [illegible]

Plant much thinner, color nearly white to creamy or pale slate
Spores 4.8-6.3 x 14.5-18μ .... *S. calcea* (1)
Spores 3.5-4 x 5.5-8.5μ; basidia near the surface .... *S. sp.* (No. 4118) (3)
Spores 3.7-4.5 x 6-9.5μ; basidia more deeply seated .... *S.* sp. (No. 4119) (4)
Growing from the ground and running up and encrusting the bases of living or lifeless objects; color buff
Sometimes with branches or flaps; hymenial layer 60-150μ thick .... *S. incrustans* (5)
Without branches or flaps; hymenial layer 200-300μ thick .... *S. Helveloides* (6)

1. **Sebacina calcea** (Pers.) Bresadola

PLATES 46 AND 60

Entirely resupinate, closely attached, forming elongated and anastomosing patches from very small up to about 5-6 cm. long and 6 mm. wide, very thin, only about 50-110μ thick; surface minutely pulverulent, dull, the closely adnate, well-defined margin white, the remainder very light drab gray. Substance sub-gelatinous or subfleshy, not to be removed in flakes.

Spores white, rod-elliptic, bent, 4.8-6.3 x 14.5-18μ, a few as short as 11.5μ. Basidia subspherical, 13-14μ thick, divided into four cells by longitudinal divisions; sterigmata long, thickish in the distal half; paraphyses forming a transparent, almost structureless, layer above the basidia, their finely branched tips loaded with crystals.

This agrees well with *S. calcea* as described by Bresadola and by Burt. It is said to grow on both coniferous and frondose trees. In the southern states it has been reported only from Georgia.

3963. On a dead branch of *Robinia pseudacacia* in Arboretum, January 12, 1920.

2. **Sebacina** sp. ?

PLATES 47 AND 61

Forming low, crowded and anastomosing, nodulated masses and pustules looking very like a mixomycete; patches 9 cm. or more long and up to 1.5 cm. wide in our collection (probably quite indefinite as to size and form of area covered); thickness up to 1 or 1.5 mm.; color a pallid creamy yellow or dusky cream; surface glabrous, shining unless getting rather dry. Texture succulent but not gelatinous

in the usual sense, but firmly waxy. Fibers of the flesh slender and regular, about 1.5-2μ thick, sparingly branched.

Spores oval, flattened on one side, yellowish under microscope, very variable in size, 6.3-9 x 7.7-12.2μ, sprouting into threads by one or two germ tubes, which may arise at any point. Basidia oval, 13.7-14.4 x 16.3μ, irregularly four-celled, collapsed soon after formation of spores. Sterigmata much thickened upward, some very long and slender. Paraphyses slender, densely packed, curved over and mostly branched a little at the ends, the branches crooked and more slender and set with very minute crystals. Much larger, roughly globular or angular crystals with slender, spine-like hyaline projections also occur rather abundantly through the hymenium; they are mostly about 7-9μ thick.

This species is markedly distinct from all others we have seen. The peculiar color, pustulate, anastomosing form, plump spores and large crystals separate it easily from our other Sebacinas. The projections on the crystals do not seem to be of the same nature as the crystals themselves and after drying reappear very obscurely if at all. They may be the stubs of hyphae that took part in the formation of the crystals. So thickly interwoven are the tips of the paraphyses and so dense the little crystals that there is formed a distinct and darker crust over the surface. We place this in Sebacina rather than Tremella because of the waxy texture, abundant, branched paraphyses and abundant crystals. Exidia is excluded by the plump spores.

4116. On underside of old, hard heart of an oak branch, on ground, west of athletic field, February 13, 1920.

3. **Sebacina.** sp. ?

PLATE 60

Plant forming a thin, extended membrane about 150μ thick which is nearly smooth or obscurely nodulated and closely adherent to the wood, the margin quite indefinite; surface dull, color a pallid milky slate with a faint tint of lavender or flesh; texture waxy; threads of context closely packed.

Spores (of No. 4118, print) white, smooth, elliptic, 3.5-4 x 5.5-8.5μ. Basidia four-celled, 7.4μ thick, ovate, situated near the surface (in some cases nearer than shown in the drawing). Paraphyses not highly specialized or branched, covered with crystals through the upper layer, parallel, upright and closely packed.

PLATE 47

SEBACINA SP. No. 4116.

In drying the membrane shrinks much, to an almost invisible film; differs from No. 4119 in slate color, smaller basidia which are near the surface, and in the closely packed threads of the flesh. Our plant agrees rather closely with Burt's description of *S. podlachica* Bres. in color, size of basidia and spores, position of basidia and closely crowded threads of the context; but he does not mention the crystals in the hymenium or refer to the species on seeing our plant.

4118. On decaying underside of piece of decorticated oak wood, New Hope Creek, February 14, 1920. Drawing.

4. **Sebacina** sp. ?

PLATE 60

Plant variable in thickness, usually about 400-500μ thick except where nodulated or wrinkled, much thinner in areas; forming an extensive slick membrane with indefinite margin, usually between bark and wood and between layers of the rotten wood, sometimes on surface also of the rotten bark; color pallid straw or clay or dull whitish; surface smooth, or nodulated and irregularly pitted and wrinkled; texture waxy, not very tough or elastic; threads of context loosely packed. The plant is not removable from the wood when fresh without breaking it into pieces.

Spores (of No. 4119, print) white, smooth, elliptic, 3.7-4.5 x 6-9.5μ. Basidia oval, four-celled, 7.8 x 11μ. Paraphyses upright, closely packed, branched near the surface into a few crooked forks on which are small crystals.

4119. On decaying gum wood, near New Hope Creek, February 14, 1920. Drawing.

5. **Sebacina incrustans** (Pers.) Tulasne

We have not yet found this in Chapel Hill, but it probably occurs here. It forms an irregular fleshy-leathery, buff crust which creeps up and around the bases of objects, often on grasses. Spores white, 6-8 x 12-14μ. For a full description see Burt. l.c. p. 752. See also a photo by Lloyd in Myc. Notes **52**: fig. 1115. 1917.

Asheville. Beardslee.

6. **Sebacina Helvelloides** (Schw.) Burt.

This is much like *S. incrustans*, but differs in its less fleshy structure and thicker hymenium. It grows on the ground among mosses

and on bark at the bases of trees. It was originally described from North Carolina by Schweinitz as a Thelephora. See Burt. l.c. p. 756, for a full description.

Salem. Schweinitz.

DACRYMYCETACEAE

Small plants growing on wood; texture gelatinous and soft or toughish-gelatinous to more or less cartilaginous; form various, upright and single or branched like a Clavaria (as in species of Calocera), or forming simple or complicated little cushions which may be smooth or much folded or more or less flattened (as in Dacrymyces) or somewhat cup-shaped or spathulate (as in Guepinia). The important distinctions are microscopic and are based on the basidia and spores. The former are branched above into two long, thick sterigmata which gradually taper to the pointed ends where the two spores are borne. The color of the plants is usually yellow or orange, and they are some times viscid. Spores smooth, elliptic, usually bent, divided across into two or more cells at least before sprouting, orange or creamy yellow. See Brefeld: *Untersurchungen aus dem Gesamtgebiete der Mykologie* 7:138. 1888. Also see Tulasne, as cited under Tremellaceae.

KEY TO THE GENERA

Plants sessile, gelatinous, pulvinate, the surface convoluted; spores divided into four or more cells before sprouting .... *Dacrymyces*

Plants with a smooth, gelatinous stalk, swollen above into a convoluted head which bears the hymenium; spores as in Dacrymyces .... *Dacryomitra*

Plants with a short, subcartilaginous stalk, the small head rounded or flattened horizontally like a carpet tack and little if at all convoluted .... *Dacryopsis*

Plants stalked, upright, spathulate, or cup-shaped, or petalloid; tough, the sterile stalk pubescent; spores divided into two cells before sprouting .... *Guepinia*

Plants stalked or subsessile by a central point, enlarged above, fleshy-tough, the hymenium gelatinous; spores divided into two cells before sprouting .... *Ditiola*

Plants stalked, upright, slender, simple or branched like Clavaria, toughish and usually viscid; stalk not pubescent; spores divided into two cells before sprouting.... *Calocera*

DACRYMYCES

Gelatinous, sessile, pulvinate, subhemispheric or flattened, usually convoluted on the surface like a brain, the entire exposed surface

covered by the hymenium, in several species with a distinct toughish root. Basidia narrow, elongated, divided at the end into two long forks which bear one spore each on distinct sterigmata. Spores yellow or orange, curved-elliptic like a sausage or one side curved, divided into cells by cross walls before sprouting. Small conidia often produced by the sprouting spores and on the surface of the young fruiting bodies. For development of basidia and other cytology see Wager in The Naturalist **695**:364. 1914.

KEY TO THE SPECIES*

Growing on pine
- Not rooted, small, watery orange or amber, or paler; nearly always on decorticated wood; spores mostly over 18μ long, divided into about eight cells before sprouting .... *D. abietinus* (1)
- Rooted, on wood with bark on
  - Bright yellow or orange, drying red and rounded; spores 18-22μ or longer, divided into about eight cells .... *D. aurantius* (2)
  - Pale smoky or watery amber; spores 10-13μ long .... *D. pallidus* (7)
  - Raisin-colored, spores 21-27μ long .... *D. punctulatus* (4)
- Rooted on decorticated wood; drying dull red-brown, and flattened; spores 13-18.5μ, long, divided into about four cells .... *D. involutus* (3)

Growing on deciduous plants
- Orange or wine-color or paler; rooted, drying reddish, spores 10.5-15μ long, divided into four cells .... *D. Ellisii* (5)
  - Small, mostly yellow with an olive tint when young, drying a dull amber color .... *D. minor* (6)
  - Small and very inconspicious, smoky-brown; drying blackish-brown .... *D. fuscominus* (8)

1. Dacrymyces abietinus (Pers.) Schroeter

D. stillatus Nees

PLATES 23 AND 63

Plant forming little pustules varying from less than one mm. to about 3-4 mm. broad, and 1-2 mm. high, gregarious or touching so as to form larger compound masses; color watery-orange or amber or fading to paler yellowish or sordid or sub-hyaline; surface feeling wet, but not viscid; not passing into the wood by a tough white root (as in *D. Ellisii* and *D. aurantius*, but apparently seated directly on the wood by the central part of the underside; texture gelatinous, but holding its shape well unless very wet and then often collapsing to a

*See notes on other species, page 17[illegible]-174

soft, shapeless jelly; no taste or odor; flesh concolorous. In drying fading down to small amber or raisin-colored droplets.

Spores (of No. 3832, spore print) deep orange, smooth, long-elliptic, mostly bent, 5.5-7.4 x 18.5-25.9μ, not divided into cells when first shed as a spore print, but later (in about a week) divided into about eight cells. Basidia forked into two long prongs.

Common on decorticated pine and cedar wood. This differs from *D. Ellisii* in the much longer spores with more numerous cells. From the good description by Persoon (Obs. Myc., p. 78. 1796) there can be no doubt that we have his plant. It is more than likely that *D. stillatus* Nees is the same, but he did not say that it grew on coniferous wood. His figure is tolerably good for our plant (Syst. d. Pilze, p. 89 (18), Pl. 22, 1858). Plants in the Curtis Herbarium under the latter name from Alabama (Peters) and South Carolina (Ravenel and Curtis) are like our plants, but specimens from Fries so labelled in the Curtis Herbarium are doubtfully the same and seem rooted (no spores to be found). Fries says that *D. tortus* grows on rotten pine wood and refers to Bulliard's *T. deliquescens* as the same. This has led to the impression that *D. deliquescens* grows on pine, a supposition which to me is more than doubtful (see remarks under *D. minor*). In the Curtis Herbarium are collections called *D. tortus* on pine and Taxodium from Society Hill, S. C. (Curtis), also one from Ravenel. These all seem to be the same as my plant. Karsten gives the spores of *D. stillatus* as 18-22 x 8μ; Hennings (Engler and Prantl, Pflanzenfamilien) as 18-28 x 8-12μ. *Dacrymyces involutus*, also on pine, has shorter spores, is rooted, and is otherwise quite different. Brefeld's conception of *D. stillatus* would exclude our plant. He has it on corticated coniferous wood (often on *P. sylvestris*), bursting through the bark in lines, more reddish than in his *D. deliquescens*, having a firm white root in the bark; spores large, 8-10-celled, 12 x 25-30μ. His plant is evidently near our *D. aurantius* Schw. if not the same.

3832. On decorticated pine logs south of athletic field, December 7, 1919. Photo.

3956. On a pine rafter on a grape arbor, January 17, 1920. Spores 5.5-7 x 15-20μ, mostly divided into about eight cells.

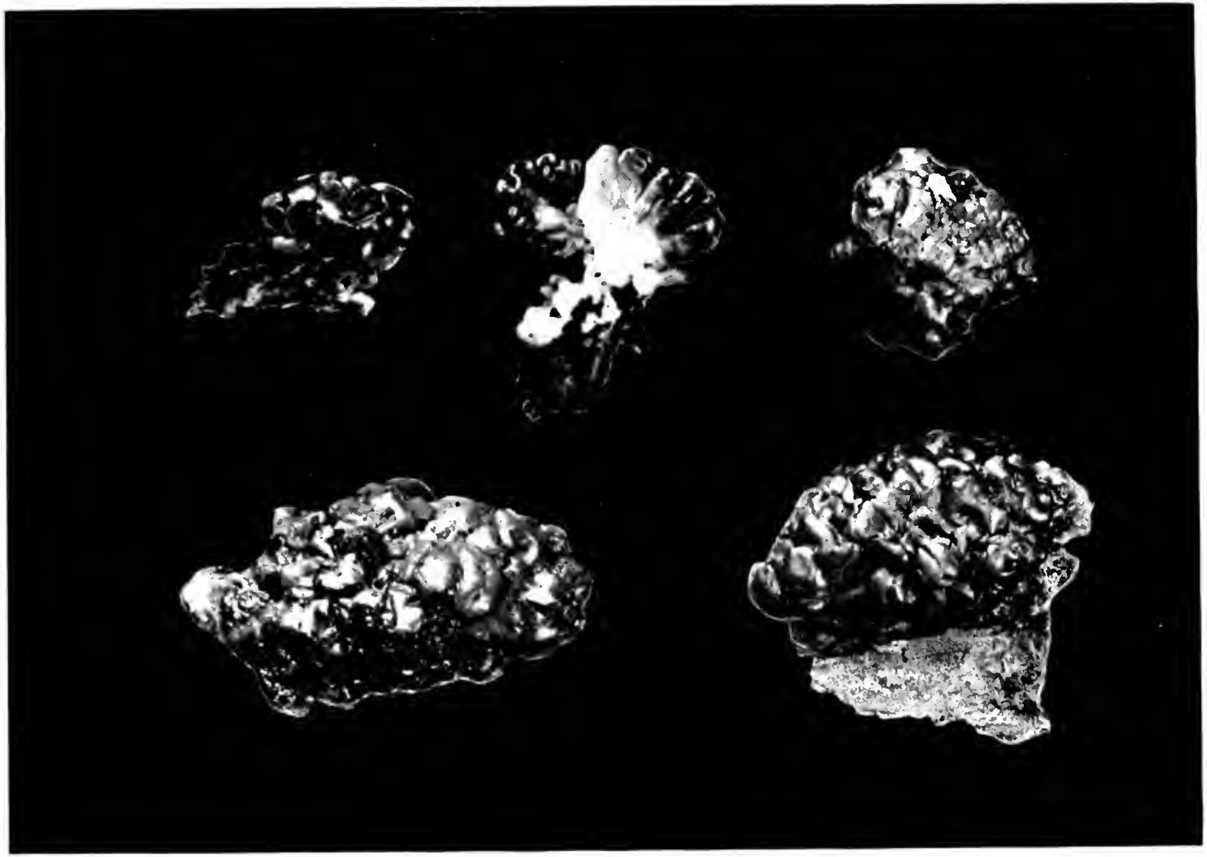
3965. On pine, January 17, 1920.

4074. On partly decorticated pine branch, February 4, 1920. Spores 5.5-7.4 x 17.4-23μ.

4132. On decorticated cedar pole in Arboretum, February 21, 1920.

Frequent on pine wood. Schweinitz.

PLATE 15



DACRYMYCES AURANTIUS. No. 3500.

2. **Dacrymyces aurantius** (Schw.) Farlow.

D. chrysospermus B. & C.

PLATES 23, 48 AND 63

Plants forming compact, rounded, brain-like, complicated masses, the surface grooved and folded through the compacting of the partly separated components; surface slimy when very wet. Color deep orange all over except where it fades into the white base which extends into the substratum as a kind of tough root. Flesh tough, sub-gelatinous, color of surface, translucent; tasteless and odorless.

Spores (of No. 3500) deep orange, curved-elliptic (sausage-shaped), smooth, 7-9-celled, the great majority 8-celled before sprouting, 5.5-7 x 18-22.5μ. Basidia slender, with two long forks.

The orange color becomes more red in the dried plants, and this character, together with the large size and the tough, white, radicating, usually flattened base, distinguishes this easily from related species except *Ditiola radicata*, which see for distinctions. It is common with us on corticated pine wood, the root extending through the bark and flattening against the wood.

Farlow's description of a plant he took to be *T. aurantia* Schw. agrees with ours. He finds the spores to be 5.5-7.5 x 20-25μ, four- to eight-celled (Appalachia **3**:248. 1883). Mr. Lloyd seems to have changed his opinion as to the species as he has seen my plants and agrees with my determination although he has illustrated something entirely different as this species (Myc. Notes Old Sp. Ser. N. **1**:11. 1908). He thinks our plant does not grow in Europe.

I find in the Schweinitz Herbarium fortunately an adequate bit of this still in the original envelope, unmounted (on a mounted part the Dacrymyces has almost wholly disappeared). The spores are just like those of our plant and unlike those of any other. They are 6.2-7.4 x 18-21μ, mostly 8-celled. In the Curtis Herbarium is an even better collection from Schweinitz (Bethlehem) under the name *T. aurantia*. It is certainly like ours, with abundant spores which are large, 8-celled, curved, 6.2-7.2 x 16.5-23μ. That *D. chrysospermus* B. & C. is also the same is thought most probable by Dr. Farlow, and the plants distributed by Ravenel (No. 466) as *D. chrysospermus* are like *T. aurantia*. Under the name *D. chrysospermus* in the Curtis Herbarium is a collection

from Massachusetts (Sprague No. 778: Curtis No. 6211) which is like *T. aurantia* and like our plants. The spores are 8-celled, 6-7 x 18-20μ. The original description of *D. chrysospermus* is as follows (adapted): "Erect, clavate-lobed, orange; spores golden, 4-6 septate. On stumps, erect, lobed above, orange, dusted with the golden spores. More highly developed than *D. deliquescens*. New England. Sprague." (Grevillea 2:20. 1873). *Dacrymyces multiseptatus* Beck of Europe on pine seems near or the same. The spores are given as 7-10 septate, 20-26 x 6-7μ (see Sacc. Syl. 6:799). It is also of interest to note that Bresadola has referred to *D. palmata* (Schw.) Bres., a European plant on bark of *Abies excelsa*, that is represented in the New York Botanical Garden by a good collection from him. This cannot be distinguished from our *D. aurantius* except that the spores average shorter (5.5-6 x 13-18.5μ, with 8 cells). Brefeld's idea of *D. stillatus* seems much more like *D. aurantius* than like *D. abietinus* (see notes under latter species).

3500. On pine log with bark, north of Meeting of the Waters, October 22, 1919. Photo and painting.

3837. On pine log with bark, south of athletic field, December 7, 1919. Spores 6-7.4 x 14.8-24μ, eight-celled.

3917. On pine log with bark, Battle's Park, December 21, 1919. Spores 7-8 x 17-26μ, eight-celled.

3985. On pine bark from fallen limbs, southeast of old graded school, January 19, 1920.

4004. On dead pine limbs with bark, near outdoor stage, Battle's Park, January 22, 1920. Spores elliptic, 6.6-7.7 x 15-23μ, some divided when shed into eight cells.

4080. On pine bark, February 4, 1920. Spores bent-elliptic, 5.5-7.5 x 14.8-22μ, eight-celled.

4193. On pine bark, February 25, 1920. Spores 6.3-7.4 x 14.8-22.3μ.

3. **Dacrymyces involutus** Schw.

D. corticoides E. & E.

PLATES 23, 50 AND 63

Forming compound, adherent, rather thin, convoluted patches reaching a length of about 6 cm., a breadth of 2 cm. and a thickness of 2-4 mm., the component parts about 3-5 mm. broad and fused with adjoining ones, each attached in center by a distinct whitish, tough, little root about 3-5 mm. long, which tapers downward to a point and is buried in the soft wood: exposed surface of the pads

orange-yellow, more or less closely convoluted like a brain, not glaucous; this form varies to gregarious colonies of smaller plants as small as 1 mm., some crowded, some single. Young plants are mostly the same orange color as older ones, but others have a distinct tint of olive as in *D. minor*, also like the latter in the protection of the very young plants by a flocculent-cottony coat, which is broken through and at times carried up for a while as a little white cap; texture toughish waxy-gelatinous; surface opaque, inner part transparent and concolorous.

Spores (of No. 3972) orange-yellow, sausage-shaped, curved, 4.3-6.6 x 13-18.5μ, soon divided after shedding into four cells. Basidia as usual in the genus, strongly two-pronged, 3.7 x 4μ thick.

A striking plant, peculiar in the distinct little round roots which descend into the wood about 3-5 mm. apart, the effect being like that of a lot of thickish and irregular thumbtacks with the heads fused, and the points stuck in the pine. It differs from the other yellow or orange species as follows: from *D. abietinus* by rooting bases, stronger color, larger masses and shorter spores with fewer cells; from *D. aurantius* in smaller and, when in masses, separate rootlets which are not so deeply penetrating, in shorter spores, in not drying red, and in occurrence on decorticated and more rotten logs; from *D. Ellisii* in larger masses, spores averaging longer and in growing on pine; from *Ditiola radicata* in unbranched and proportionally smaller stalks, absence of viscidity, occurrence on decorticated wood and in not drying red; the spores are nearly alike.

We have examined the type of *D. involutus* Schw. in his herbarium and find that it agrees with our plant, showing the characteristic form and the flocculent covering in youth. The spores agree perfectly except that they are not quite so long, a matter of small importance as the length of spores in this genus varies considerably in different collections. In the Schweinitz collection they are elliptic, curved, about 4-celled, 5.5 x 12.5μ. Schweinitz's description is as follows:

"Of the size of *D. stillatus*, subrotund-dilated, gyrose-plicate, pale golden. Base covered with fibrous white tomentum which often grows over the whole fungus. Related to *D. lacrymalis*, on old wood at Salem and Bethlehem."

This is certainly *D. corticoides*, collections of that species determined by Ellis at the New York Botanical Garden, agreeing perfectly and the description agreeing in convincing details (Jour. Myc. 1:149. 1885). The "narrow, white, subbyssoid margin" appears clearly in our plants when drying undisturbed. The color of the dried plants is a dull reddish-brown with yellow areas;

partly dried plants are more orange than fresh ones. Lloyd has seen our plants and thinks them *Arrhytidia flava* Berk., which in a letter he says is "certainly co-generic and possibly the same as *D. corticoides*." See also Myc. Notes **61**, fig. 1780. 1919. Patouillard also thinks the species should be referred to Arrhytidia as it is not truly gelatinous. This is also indicated by the fact that dried plants do not revive at all well when moistened again. For variety *conigena* E. & E. (spelled *canigena* in error) on pine cones see Jour. Myc. **2**:87. 1886. From the description it would seem than *D. confluens* Karst. might well be the same thing (Sacc. Syl. **6**:801). I have retained our plant for the present in Dacrymyces to avoid a multiplicity of closely related genera.

3972. On a decorticated, rotten pine log by path to Meeting of the Waters, January 17, 1920. Photo.

4079. On a decorticated pine log near Meeting of the Waters, February 4, 1920.

4179. On decorticated pine, February 26, 1920. Spores curved-elliptic, orange, four-celled, 5-7 x 11-14.8μ.

4. **Dacrymyces pedunculatus** (B. & C.)

Exidia pedunculata B. & C.

PLATES 23, 41 AND 62

Plants single or crowded and compounded into groups or rows up to 3 cm. long, simple individuals 2-3 mm. broad, 1.5-6 mm. thick, turbinate, rooted by a stout base, the flat top margined. Texture rather softly gelatinous, the stem tougher; color of raisins or a little paler; surface dull, minutely granular under a lens.

Spores (of No. 4158) very large, elliptic, 9.3-11 x 21-27μ, eight-celled soon after falling, orange with a tint of salmon, soon sprouting into small, elongated sporidia 1.7-2 x 3.5-4.5μ, which may be borne in groups. Basidia very large, 108-130μ long, 9-9.5μ thick.

The simple plants are shaped about like a short horseshoe nail and approach in form *D. involutus;* the flattish top may have a few wrinkles or be quite smooth. The root is about 2-4 mm. long and ends in a paler but not white mycelium which runs between the bark and wood. Compound groups are rooted by an elongated flat plate which gives rise to a crowded and convoluted group of heads much as in *D. aurantius*. The species is very distinct not only in the very large spores and basidia but also in the color, which is about that of *Exidia gelatinosa*. It is odd that the spores are so differently colored from

the plant, but several good prints make the color certain. It will be remembered that in *Tremella colorata* Peck states that the spores are of the same raisin color as the plant. There is fortunately in existence in the Curtis Herbarium a good collection of *Exidia pedunculata* B. & C. (Society Hill, S. C., No. 3750), which I find on examination is certainly this. They are on pine with same shape and color, thick spores unmistakably the same but averaging somewhat shorter than in our specimens. They are 8-celled, 7-10 x 16-22μ.

4158. On a fallen, corticated branch of *Pinus Taeda*, February 21, 1920.
4185. On a corticated pine branch, Strowd's lowgrounds, February 25, 1920. Photo. Spores 9.7-14 x 20.5-27μ.

5. **Dacrymyces Ellisii** n. sp.

PLATES 23, 50 AND 63

Plants bursting through the bark and forming small, flattish, smooth or crumpled pustules about 2-6 mm. wide which are sometimes crowded into somewhat larger masses up to 15 mm. wide; the pustules lie flat on the substratum but are the expanded tops of tough, whitish stalks which are hidden by the bark into the cracks of which they descend for several mm. and finally fade into the white mycelium; surface damp, somewhat viscid, firmly gelatinous, orange or wine-color, fading to pale or sordid yellowish.

Spores (of No. 3861) deep orange, smooth, sausage-shaped, bent, a part of them divided into about four cells when shed, 5-7 x 10.5-13.3μ.

The species is somewhat scarce in American herbaria and seems to have no settled name. It occurs in the Curtis Herbarium (Massachusetts, Sprague, bark of oak) under the name *D. deliquescens*, but it cannot be that species. Others so named in the same herbarium are different, one from Massachusetts seeming to be *D. abietinus*. I have tried to find out what *D. syringae* really is but have not succeeded. The Flora Danica figure (Pl. 1857, fig. 3) does not help much. *Dacrymyces syringicola* is different (see p. 171). Plants at the New York Botanical Garden on magnolia labelled *D. diplocarpus* E. & E., but apparently never published, have spores 3-septate, 4-5 x 11-13μ and seem the same as ours. They were sent by Ellis to Patouillard who said he did not know it. A similar collection by Ellis on magnolia bark is labelled *D. syringae*. Another collection on oak of the same thing from West Virginia (Nuttall) was sent to Massee who determ-

ined it as *Tremella enata* B. & C., which is certainly different if Curtis' No. 2456 can be said to represent it (see page 149). Lloyd has seen our plant and says: "This is not sure to me for it is too permanent and the spores of *deliquescens* are not orange but pale yellow." The species is certainly different from *D. minor* (*D. deliquescens*) which grows on decorticated wood, has much paler spores, and less orange and less complex fruit bodies without distinct roots and which become very inconspicuous when dry. It does not seem impossible that *Dacryopsis Ulicis* (Plour.) Sacc. may be our *D. Ellisii.* The appearance is much the same and the spores 4-celled, 5 x 15-18μ. (See note under *Dacryopsis ceracea*). From *D. abietinus* and *D. aurantius,* the other conspicuous yellow or orange forms, it differs in growing on deciduous wood and in the much shorter spores; from the latter it differs also in smaller size, but is like it in having a toughish, contracted, white rooting base.

3861. On branches of peach in a brush heap, December 9, 1919. Photo. Type.
3918. On decaying maple limb, December 21, 1919. Spores orange, smooth, sausage-shaped, some bent, 5.5-7.4 x 11-14μ. Spores sprouting on slide with from one to four sprouts, some three-septate.
3982. On decaying oak log, January 18, 1920. Spores bent-elliptic, 4.8-6 x 10.5-12μ, soon divided into four cells.
4003. On fallen oak limb, January 22, 1920.
4035. On decaying maple limb with bark, January 25, 1920. Spores sausage-shaped, 4.8-6.7 x 12-15μ, 4-celled before sprouting.
4036. On piece of decayed oak, January 25, 1920. Painting.
4120. On bark of decaying birch limb, February 14, 1920. Spores 4-5 x 12-14.8μ.
4170. On a corticated oak branch, February 23, 1920.

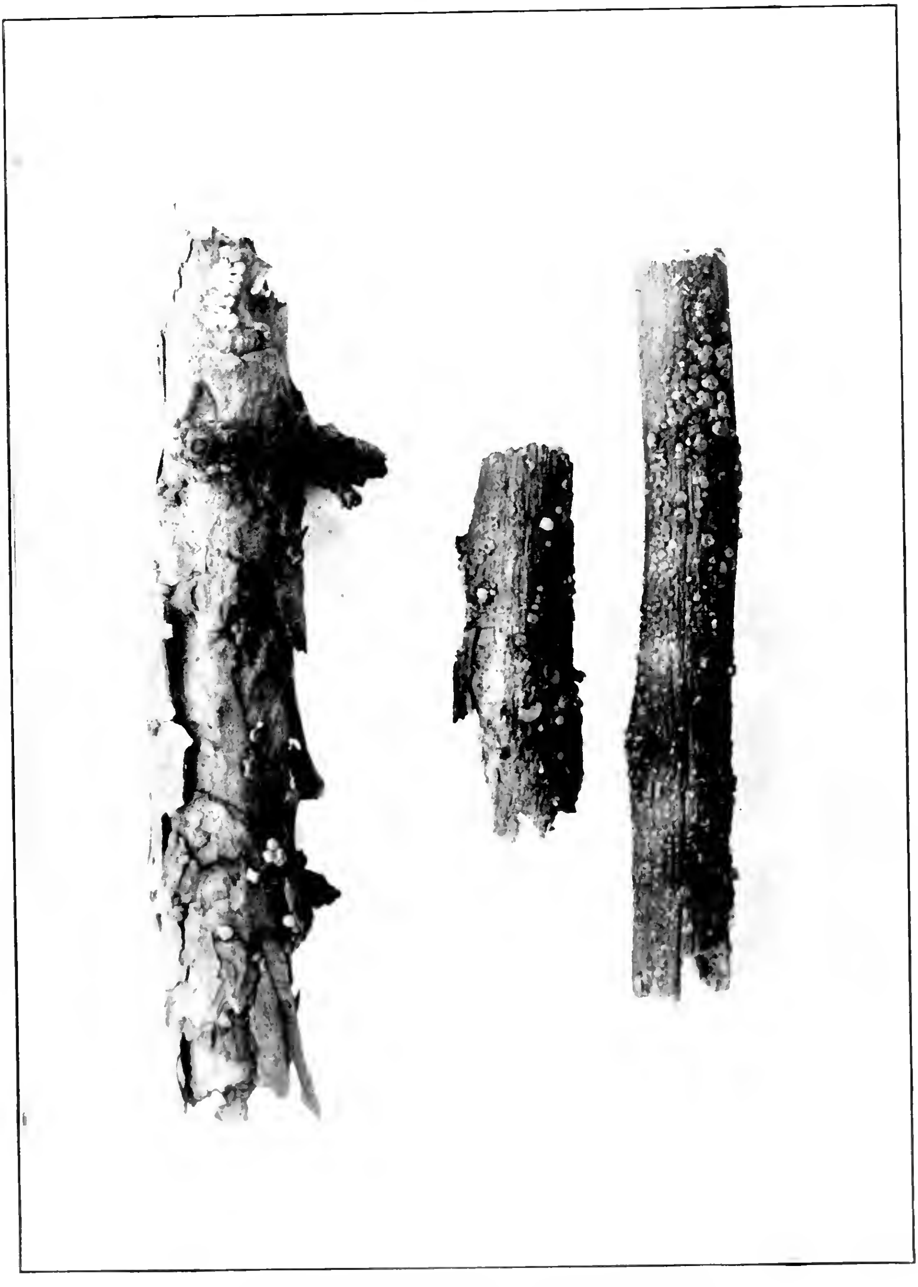
6. **Dacrymyces minor** Pk.

?*D. deliquescens* (Bull.) Fr.
?*D. lacrymalis* Pers.
?*D. hyalinus* Quelet

PLATES 49 AND 64

Plant forming very small subspherical pustules about 1-2 mm. in diameter, at times crowded into somewhat larger masses; the surface sparingly convoluted or even, a little viscid, not with an obvious root; color of most a dull, translucent, light amber or smoky amber and usually with a slight olive tint especially when young, some plants mixed with the others are a more conspicuous yellow-amber; texture rather firmly gelatinous.

PLATE 49



DITIOLA RADICATA. No. 4109 (right).
DACRYMYCES MINOR. No. 4105 (left).

Spores (of No. 3926) pale yellow, curved, divided into (mostly) four cells, 4-6.6 x 11.1-14.8μ. Basidia as usual.

In No. 3941 some of the plants were very young and when just bursting through were covered over by a white flocculent coat through which they burst at the top or at times carried up for a while as a little white cap-patch. This we have noticed elsewhere only in *D. involutus*. In No. 3926 the plants after reaching full size collapsed in at the top and looked a good deal like small Pezizas, a rupture occurred in the firmer outer part, the margins of which turned inward and downward, leaving a crater into the softer part within. This is a character assigned to *D. chrysocomus* and this is what usually passes for that species and which it may in fact be.

There is no doubt that this is Peck's species, the description and the type agreeing in all particulars. Peck gives the spores as 5 x 12.7-15.2μ (my measurements from part of type kindly sent by Dr. House are 3.8-4.5 x 10.5-13μ). They also seem to agree quite well with plants collected at Asheville by Beardslee and referred by Lloyd to *D. hyalinus* (Myc. Notes 58:828. 1919). Beardslee writes me that his plants also grew on decorticated, deciduous wood. The species differs from *D. Ellisii* in smaller size, absence of an obvious root, different color (at least when dry), white coat when just appearing (?), and spore cells more swollen when sprouting. Dried plants of *D. minor* look like minute drops of brownish amber and are almost invisible without a lens, while those of *D. Ellisii* are reddish, larger, and more conspicuous. It is more than probable that this is the true *D. deliquescens*. Lloyd has seen our plants and refers them to that species, and from Bulliard's description and figure there is no reason to conclude that it grows on coniferous wood. The assumption is rather to the contrary as he warns against confusing it with droplets of sap found on certain deciduous trees mentioned. Fries considered his *D. tortus*, which grows on coniferous wood, the same as *D. deliquescens*, and there is much confusion in Europe in regard to the latter species, which is usually said to grow on coniferous or on both coniferous and deciduous wood. For example M. Patouillard who has had the kindness to give me his conception of *D. deliquescens* and to send me a good specimen from his herbarium, writes as follows: "Almost everybody indicates this species only on conifers. But one meets it also on every sort of rotten wood." On examination we find this specimen to agree in all essentials with our *D. minor*. Bresadola is

also of the opinion that it grows on both kinds of wood, and notes its occurrence on *Quercus*, *Carpinus*, and *Pinus sylvestris* (Ann. Myc. 1:115. 1903.) Brefeld (l.c. p. 141) describes *D. deliquescens* carefully, and there are no serious discrepancies between his plants and our *D. minor*. He gives the spores as faintly yellow, 5 x 15; the plants growing on deciduous wood and seated directly on the wood, not on bark. Bresadola gives the spores of *D. deliquescens* as 12-15 x 5-6μ. It seems even less doubtful that *Tremella lacrymalis* Pers. is not different from *D. minor*. Persoon's figure (Icon. Fung. Pl. 10, fig. 3, 1803) looks about right, the plants growing on deciduous wood, the largest one about 4 mm. broad. He describes it as rounded to somewhat irregular, pezizoid, small, pellucid, yellow. Occasional on putrescent wood. He refers to Bulliard's *Tremella deliquescens* as related (Syn. Fung. p. 628. 1801). Brefeld describes a new species *D. lutescens* very near *D. deliquescens* but differing in the absence of fruiting bodies which bear gemmae, in the clear orange color, and the larger spores, 10 x 28μ. *Dacrymyces cerebriformis* Bref. is somewhat similar to the two preceding, but is smaller, prefers birch, and has 4-celled spores more curved than the other two, 8 x 25-28μ. There are still two other little species described by Brefeld, one *D. longisporus*, scarcely larger than a pin head, found on old fences; it is pale, yellow, spores 12- to 15-celled, 15 x 35-40μ; the other, *D. ovisporus*, a remarkable form with oval spores, 15 x 20-25μ, which are divided into many cells by walls in all directions. Otherwise the species, he says, cannot be distinguished from the preceding and occurs with it.

3926. On an old oak chip, December 22, 1919.

3941. On twig of deciduous tree, December 22, 1919.

3945. On *Ligustrum chinense* in Arboretum, January 16, 1920. Many of the young cushions have an olive tint added to the amber. Spores about 4.8 x 12.5, not divided into cells when first shed.

4012. On a fallen branch of osage orange (Maclura), January 23, 1920. Spores creamy yellow, curved, 4-5 x 10-13, mostly divided into four cells which soon sprout, forming either small sporidia or mycelial threads.

4105. On a decorticated branch of osage orange, February 13, 1920. Spores 3.7-5 x 10-12.5. Photo.

4165. On corticated dogwood branch, February 23, 1920. Growing mostly in lines across the twigs through circumcissile cracks in the bark. Washed out to almost hyaline. Spores 6-7.4 x 13-15.5, 4-celled.

4166. On decorticated oak branches, February 23, 1920.

4181. On decorticated sycamore wood, February 26, 1920. Spores 3.7-5 x 9.3-11.2, 4-celled.

4200. On crepe myrtle, March 5, 1920.

7. **Dacrymyces pallidus** n. sp.

PLATE 61

Bursting through cracks in the bark of pine and forming elongated, irregular, pulvinate, convoluted patches up to 1.5 cm. long, 2.5-4 mm. broad and 2-3 mm. high. Texture firmly gelatinous. Color varying from nearly hyaline (a very pale, watery amber) to a pallid amber-clay or faint smoky amber. The patches are attached by a flattened root which passes through the bark and spreads out a little on the wood, but does not enter it.

Spores (of No. 4072) 4-4.5 x 10-13μ long, occasionally septate with one cross wall.

This is quite different from any of the other species. It is the palest. The absence of orange color and the shorter spores separate it easily from *D. aurantius* and *D. involutus*, the shorter spores and different form from *D. abietinus*, the absence of orange color and growth on pine from *D. Ellisii* and the quite different form, larger size, distinct root and growth on pine from *D. minor*. There is no exposed stalk.

4072. On a pine branch with bark on, February 4, 1920. Photo and drawings. Type.

4162. On corticated fallen pine branch, February 22, 1920.

8. **Dacrymyces fuscominus** n. sp.

PLATE 63

Minute, flattish, convoluted clusters up to 5 mm. long and 1-2 mm. wide, less than 1 mm. thick; color sordid smoky, with clay tints in places, almost the color of the bark, very firmly gelatinous, almost waxy, the fibers closely packed and not separated by jelly.

Spores elongated, a little bent, 3.5 x 8.5-10.5μ. Basidia forked.

This is nearest *D. pallidus* which differs in larger size, lighter color, less hard consistency and slightly longer spores, also in growth on pine. The very firm texture of the plant distinguishes it from all other species of Dacrymyces and it would perhaps be better to refer it to the genus *Ceracea* except that the few described species of that genus form very thin, completely effused plates which are not convoluted, having the habit of a Sebacina, a waxy consistency, and the basidia of a Dacrymyces. *Ceracea vernicosa* Cragin, found in Kansas, covers with a thin coat undeveloped plants of a Polyporus (see Am. Myc. 1:58. 1885). *Ceracea Lagerheimii* Pat. grows on wood in the

eastern tropics, is ochraceous, waxy, resupinate, 2-5 cm. long; basidia 5 x 40-60μ; spores 5 x 10-12μ, with one septum in the center (Bull. Soc. Myc. de Fr. 9:141. Pl. 8, fig. 5. 1893). In the Curtis Herbarium is a collection from Schweinitz (Bethlehem on Acer) labelled *D. virescens* Fr., which looks a good deal like our No. 4075. His plants are very small, pulvinate, much convoluted, blackish when dry, sordid, smoky ochraceous when wet; texture waxy or dense. I could get no spores from the plants and no distinct basidia.

4075. On oak bark, back of Athletic Field, February 4, 1920. Type.

We include the following notes for the convenience of students:

Dacrymyces syringicola B. & C. A collection from Society Hill, S. C., labelled *D. Syringae* Fr., in the Curtis Herbarium, bursting through the bark of dead lilac twigs, is not a Dacrymyces, but is made up at least superficially of large more or less rectangular bodies resembling parenchymatous cells. A collection of the same thing from Santee Canal, S. C. (Ravenel), is labeled *D. destructor* B. & Rav. It was found on a dying pear branch. This last is supposed to be the same as *D. syringicola* B. & C. by Massee.

Dacrymyces violaceus Fr. is reported by Schweinitz from North Carolina on apple wood. There is a bit of decorticated apple branch under this name in the Curtis Herbarium, but there is apparently nothing left on it of value. Fries described the species as "small, compact, subcompressed, gyrose, violaceous, on trunks of pears" (Epicrisis, p. 592).

Dacrymyces chrysocomus (Bull) Fr. is represented in the New York Botanical Garden by a good collection from Bresadola on corticated pine twigs. The plants are small, amber-colored, collapsed to a membrane; spores thick, divided into about eight cells, 9.3-12 x 18-21μ. Brefeld gives the spores of the species as up to twenty-celled, 15 x 35μ. We have not found anything like this.

Dacrymyces conglobatus Pk. (Rep. 32: 37. 1879) is evidently not a Dacrymyces. He also reports *D. fragiformis*.

Dacrymyces fragiformis (Pers.) Nees. There is evident confusion here. In the original description Persoon says: "Subcompact, rounded, red, folds crowded, somewhat lobed. When dry 4-6 lines broad, otherwise as large as an inch across, color fading, internally pale. On bark of pine" (Syn. Fung. p. 622. 1801). His fig. 1, Pl. 10, in Icon. Pict. shows the plants crowded, of good size, reddish outside, white within. Quelét gives the spores as 40-60μ long, triseptate (Fl. Myc. Fr. p. 17. 1888). Herter gives the spores as 20 x 7μ, many septate, and says the species is doubtful (Krypt. Fl. Mark B. 6:56. 1910). See also Rabenhorst's Kript. Fl. 1:277. 1884. Albertine and Schweinitz introduced confusion by assigning to this species a form β *carpinea*, an entirely different plant that grows (apparently parasitically) on the fruiting body of the black, encrusting Ascomycete *Diatrype stigma* (formerly Sphaeria or Hypoxylon) on twigs of frondose wood. Schweinitz reports this as *T. fragiformis*,

not as the variety, in both Syn. Car. (No. 1147) and Syn. Am. Bor. (No. 1121). We have this little plant in plenty at Chapel Hill and find it in no way related to this group of fungi, the only resemblance being the subgelatinous texture and external form. The plants are very small, deep red, scarcely as large as a clover seed, scattered or approximated. *Dacrymyces macrosporus* B. & Br. is apparently the same. No one seems to know what the original *T. fragiformis* of Persoon is.

The following are translations of Schweinitz's original descriptions of species of Dacrymyces:

Dacrymyces pellucidus Schw. (No. 1129. Syn. Fung. Amer. Bor. p. 186: 1832): "Large, extending 3 inches in length and breadth, white, subpellucid, in the growing state, resembling the early stage of a gelatinous Hydnum; the form is also gyrose like a Tremella, variously lobed, with thick blunt lobes. The internal structure is entirely that of a Dacrymyces. In the dry state it presents a hard thick membrane, plicate-veined, pellucid. Large, rather rare on wood at Salem; also seen near Philadelphia." A good plant in the Schweinitz Herbarium shows this to be a Tremella or Exidia with 4-celled basidia about 9.3μ thick. It is probably *T. fuciformis.*

Dacrymyces capitatus Schw. No. 1130. Syn. Fung. Amer. Bor. p. 186): "Stipitate, penetrating the stem (of Brassica) with its stalk, base tomentose, thick, scurfy (resembling a Ditiola), ending in a globose head, often compressed, sometimes plicate, reddish golden in color. It grows scatteringly. Internal structure exactly that of this genus. Seen on the stem of Brassica, Bethlehem." Possibly a true Dacrymyces, but a slide shows no spores nor developed basidia.

Dacrymyces difformis Schw. (No. 1130. Syn. Fung. Amer. Bor. p. 186): "Multiform, variously contorted, bursting from the epidermis almost like a Myxotrichus, reddish golden, subexpanded. Internal structure as in the others. Rare on the twigs of rose clusters, Bethlehem." A collection from Philadelphia by Schweinitz shows a few small plants on a rose branch about one centimeter thick. A slide shows nothing decisive.

Dacrymyces epiphyllus Schw. (1132. Syn. Fung. Amer. Bor. p. 186): "It immediately recalls a Sclerotium, but afterward slowly shows the internal Dacrymyces structure. Gregarious, subrotund or oblong, yellowish, minute, one-half line broad, sub-pulvinate, as if inherent, often subconfluent. Seen on the leaves of Galium at Salem." A good collection in Philadelphia shows no evidence of being a Dacrymyces. It scarcely swells when wet, and the internal structure is unlike this genus.

Dacrymyces viticola Schw. (No. 1133. Syn. Fung. Amer. Bor. p. 186): "Two-formed. Bursting forth from the cortex or epidermis, provided with a thick stalk, base obscured or covered with tomentum, expanded above into a reddish-orange gyrose head. Also on decorticated wood, effused, gyrose-plicate, thin, of the same color. Each form preserves the internal structure of a Dacrymyces. Rare, bursting forth from the epidermis of dead grape, Bethlehem." In Philadelphia both forms are represented. A slide of the second form

shows basidia and spores of the Dacrymyces type, the latter, few in number, about 4.4 x 11μ, apparently 4-celled. (Lloyd says there is a specimen of this at Kew.)

Dacrymyces azaleae Schw. (No. 1134. Syn. Fung. Amer. Bor. p. 186): "Scattered, minute, bursting from the bark as a Myxosporium, yellowish-golden, pellucid, expanded into a subpalmately-lobed head, short. Internal structure as above. Rare on dead branches of *Azalea nudiflora*. Bethlehem." The type in Philadelphia shows minute globules, barely visible without a lens, reddish, scattered, pale and toughly gelatinous when wet and seen to be compounded. Probably a true species. A preparation has the general appearance of Dacrymyces, but no spores nor good basidia were found.

Dacrymyces cinnabarinus Schw. (No. 1127. Syn. Fung. Amer. Bor. p: 186): "Small, erumpent, attached closely to the epidermis, at first convex, at length concave and subpezizoid, color brilliant cinnamon, often confluent, and covering the branches with large colonies, longitudinally effused. It is easily shaken off, separating from the substratum. When soaked in water the interior appears distinctly floccose. Frequent on Willow branches, Bethlehem." We have examined the type and find it to be a typical Ascomycete, with plentiful asci containing eight spores.

DACRYOMITRA

Plant stalked, the stalk smooth, gelatinous, enlarged above into a more or less flattened, convoluted, viscid head, which is more or less bent over and is covered by the gelatinous hymenium. Spores elongated, orange, divided into four cells before sprouting. Basidia as in Dacrymyces. Distinguished from Ditiola by the larger size, different shape and the larger, four-celled spores; from Dacryopsis by the large size, more convoluted head, more gelatinous texture and larger spores. We have but one species.

Dacryomitra dubia Lloyd

?*Dacryomytra glossoides* (Pers.) Bref.

?*Dacrymyces flabellus* Ellis

PLATES 23 AND 64

Plant 12 mm. high, the stalk 9 mm. long and 3.5 mm. thick, orange-yellow, smooth, gelatinous; the cap irregular, flattened, and bent over, 6.5 mm. broad, 3 mm. thick, convoluted, orange, gelatinous.

Spores large, orange, resembling those of Dacrymyces, 6.3-8.1 x 13.3-17μ, rarely up to 20μ, average 7 x 16μ, divided into four cells before sprouting. Basidia slender and two-forked, about 4.4μ thick.

PLATE 50

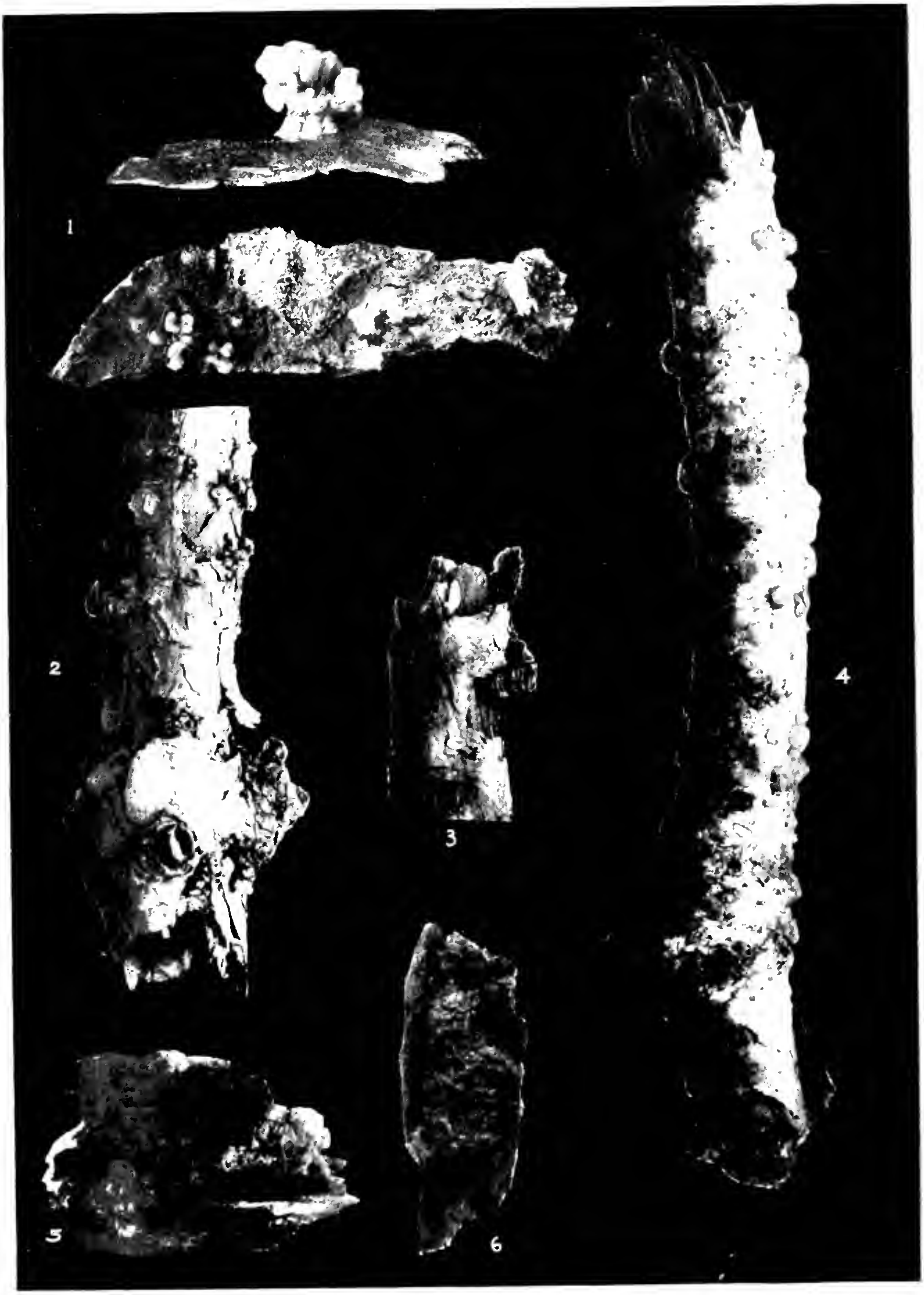


FIG. 1. DACRYOPSIS CERACEA No. 4121
FIG. 2 & 3. DITIOLA RADICATA No. 418[illegible]
FIG. 4. DACRYMYCES ELLISII. No. 417[illegible]
FIG. 5 & 6. DACRYMYCES INVOLUTUS No. [illegible]7

The plant is distinctly viscid when wet. The stalk sits flat on the wood to which it is attached by a flat, tough, whitish plate which enters the wood vertically. Quite young plants are filiform at first, the head not apparent.

This agrees perfectly with *D. dubia* as figured and described by Lloyd (Myc. Notes **52**:742, fig. 1114. 1917). Lloyd does not state on what kind of wood his plant grows, but the European *D. glossoides* is said to grow on beech. This is apparently the only serious discrepancy in the habit or structure of that species and ours. Our plant is much more gelatinous than *Dacryopsis nuda.*

3969. On a pine log, woods back of athletic field, January 17, 1920. Painting.

DACRYOPSIS

Plant stalked and rooted, the stalk short, smooth or granular, subcartilaginous, capped above by a rounded or horizontally flattened, smooth or only slightly convoluted, viscid, toughly gelatinous head. Often compounded by branching of the root or stalk. Spores elongated, divided into two or four cells before sprouting. Basidia as in Dacrymyces. We have but one species (but see note under *Ditiola radicata*). For *D. gyrocephala* (B. & C.) Massee, from South Carolina, and for other species of Dacryopsis see Jour. Myc. **6**:181. 1890.

Dacryopsis ceracea n. sp.

PLATES 50 AND 65

Plant 4-6 mm. high, mostly compound from a flattened, tough, whitish rooting base, branched at once into a few stout stems which expand and crimp above where they are capped and covered by a glabrous, shining hymenium, which is deep wax-yellow and descends irregularly from the tip only about 2 mm. at most. Stem finely granular, dull, distinctly demarked from the hymenium and a little paler. Spread of the largest clump in our collection 1.3 x 1.9 cm.; a few simple plants stand alone with the unbranched stems capped with the smooth hymenium. Tips thick, bluntly rounded, about 1.5 mm. thick. Texture gelatinous, elastic, subtranslucent, the rooting base tougher. The base penetrates cracks in the bark and flattens out on the wood below. The hymenium is scarcely more convoluted than is necessary to follow the wavy apex it is situated on. In a few of the broader tips the hymenium is depressed and a little convoluted in the center. The plant has the habit of *Sparassis Herbstii* on a minute scale.

Spores (of No. 4121, print) smooth, wax-colored, slightly bent-elliptic, divided into two cells before sprouting, 3.7-4.4 x 7.4-10μ. The spores sprout by short sterigmata which bear single subspherical sporidia. Basidia divided into two prongs, slender, 3.4-4μ thick.

This seems certainly Dacryopsis, and of the described species only *D. Ulicis* (Plowr.) Sacc. is at all near in color, but that has spores 4-celled, 5 x 15-18μ and is otherwise different (Trans. Brit. Myc. Soc., 1:55. Pl. 2, figs. 2-6, 1898). *Dacryopsis Ellisiana* Mass. (*Coryne Ellisii* Berk.) was described from New York on decaying basswood log. According to Cooke it has spores continuous, 4-4.5 x 15μ (Grevillea 20:24. 1891).

4121. On piece of decaying oak limb, New Hope Creek, February 14, 1920. Type.

GUEPINIA

Small, tough, semi-gelatinous, upright, stalked, the stalk tomentose or scabrous, enlarged above where it is flattened or branched or lobed or wrinkled; hymenial surface confined to one side, limited below, i.e., the stalk not covered by it; basidia forked above into two long prongs; spores smooth, elongated, curved (sausage-shaped), orange or yellow, divided into two or more cells before sprouting; dorsal surface said to bear chains of conidia. Distinguished from Calocera by the broadened or thickened upper part with basidia on one side only, by the slippery but not viscid surface, and by the tomentose stem.

KEY TO THE SPECIES

Growing on deciduous wood, stem and sterile surface deep rich brown; hymenium not orange..........................*G. elegans* (1)

Growing on deciduous and coniferous wood; hymenium orange when fresh..*G. spathularia* (2)

Guepinia elegans B. & C.

It is rather surprising that we have not yet found this in Chapel Hill as it occurs both north and south of us and is reported by Curtis from this state. The following description is made from dried plants in the Curtis Herbarium (from South Carolina and Alabama) and the New York Botanical Garden Herbarium:

Plants cespitose or single, up to 2 cm. high, the distinct stalk terete, 5-8 mm. long, deep reddish brown, finely squarrose-tomentose, expanding above rather abruptly into funnel-shaped or fan-shaped

cap up to 1-2 cm. broad, the outside or sterile side continuing the surface and color of the stalk, the inner or fertile face smooth, glabrous and very dark blackish-brown (when dry). Basidia with two long prongs each about 3.8μ thick at base. Spores elliptic, somewhat bent, four-celled, 4.5-6.3 x 11.5-16μ. The plant is very different from *G. spathularia* and is easily distinguished by it colors and spores. It is known from New York to Brazil, and in the United States is, in the opinion of Lloyd, probably confined to elm. Lloyd also thinks that it is the same as *G. biformis* Pk., *G. bicolor* Pk. and *G. juruensis* Hennings. See Myc. Notes **58**:825, fig. 1378. 1919.

Low and upper districts on trunks and logs. Curtis.

Guepinia spathularia (Schw.) Fr.

PLATES 23, 51 AND 64

This is a small, upright, spathulate plant with a distinct stalk which is simple or more or less branched and furrowed; growing in lines and clusters from dead, deciduous wood; height about 0.5-2 cm.; width about 2-5 mm. at the flattened spathulate or petal-like tip; stalk distinct, up to 1.5 cm. long, flattened above, rounded below, running through cracks in the bark down to the wood, base scurfy tomentose, the tomentum becoming finer upward and extending onto the sterile side of the expanded cap as a very fine pulverulence. Hymenium orange-yellow, rugose wrinkled longitudinally like a Cantharellus, confined to one side of the flattened upper part and distinctly delimited from the stem; sterile surface as deeply colored as the hymenium when damp, but becomig a light yellow or cream color when dry, the hymenium remaining orange; stalk brownish-yellow above, darker brown below; texture of entire plant tough, firm, subgelatinous.

Spores (of No. 3892) smooth, orange-yellow, elliptic, curved, 3.8-4.5 x 7.4-9.5μ, sprouting to form small, spherical conidia on short stalks, dividing into two cells before sprouting. Basidia long and deeply bipartite.

Not rare on logs and crossties of deciduous wood and on pine and cedar. On long soaking or exposure to rain the plants become faded to a pale amber or straw color. The size and form of this species are very variable. We have some on pine and cedar that are simply swollen above into a kind of rugose club with one side sterile (see Pl. 23, fig. 14) and from this form there are variations up to an ex-

panded, petal-like form with strongly crimped margins. A good many species have been described in this genus, most of which are certainly without validity. I am including in this species both the form on deciduous and that on coniferous wood, but I am not at all sure that they are the same. However, as the basidia and spores cannot be distinguished and there are a number of forms on both kinds of wood, I have not separated them.

1073. On an oak log near Howell's spring, October 18, 1911. Drawings.
3377. Dead branch of oak, June 28, 1919. Spores 3.7-4.8 x 8.5-11μ. Photo and painting.
3852. On pine pole on basketball court of old graded school, December 9, 1919. Spores smooth, orange-yellow, elliptic or curved, 3.7-5 x 9-11.1μ.
3892. On decaying wood of deciduous tree in Stroud's lowgrounds, December 13, 1919.
3913. On cedar posts at The Rocks, December 16, 1919.
3984. On oak wood back of athletic field, January 17, 1920.
3998. On a pine rail on a grape arbor, January 22, 1920.
4008. On cedar poles, arbor at the Rocks, January 23, 1920. Spores 3.8-6 x 7.7-10.5μ, a few longer; divided into two cells before sprouting.
Blowing Rock. Atkinson.
Common on pine wood. Curtis.

DITIOLA

Plants small, centrally stalked or seated by a point, enlarged above with the hymenium over the enlarged part; at times like a small Peziza, with the flat upper surface covered by the hymenium; not tomentose. Flesh toughish-fleshy, only the hymenium gelatinous. Spores elliptic, two- or four-celled before sprouting. Basidia as in Dacrymyces, etc. Distinguished from Guepinia by the smooth stalk (if present) and hymenium not lateral. We have found only two species.

KEY TO THE SPECIES

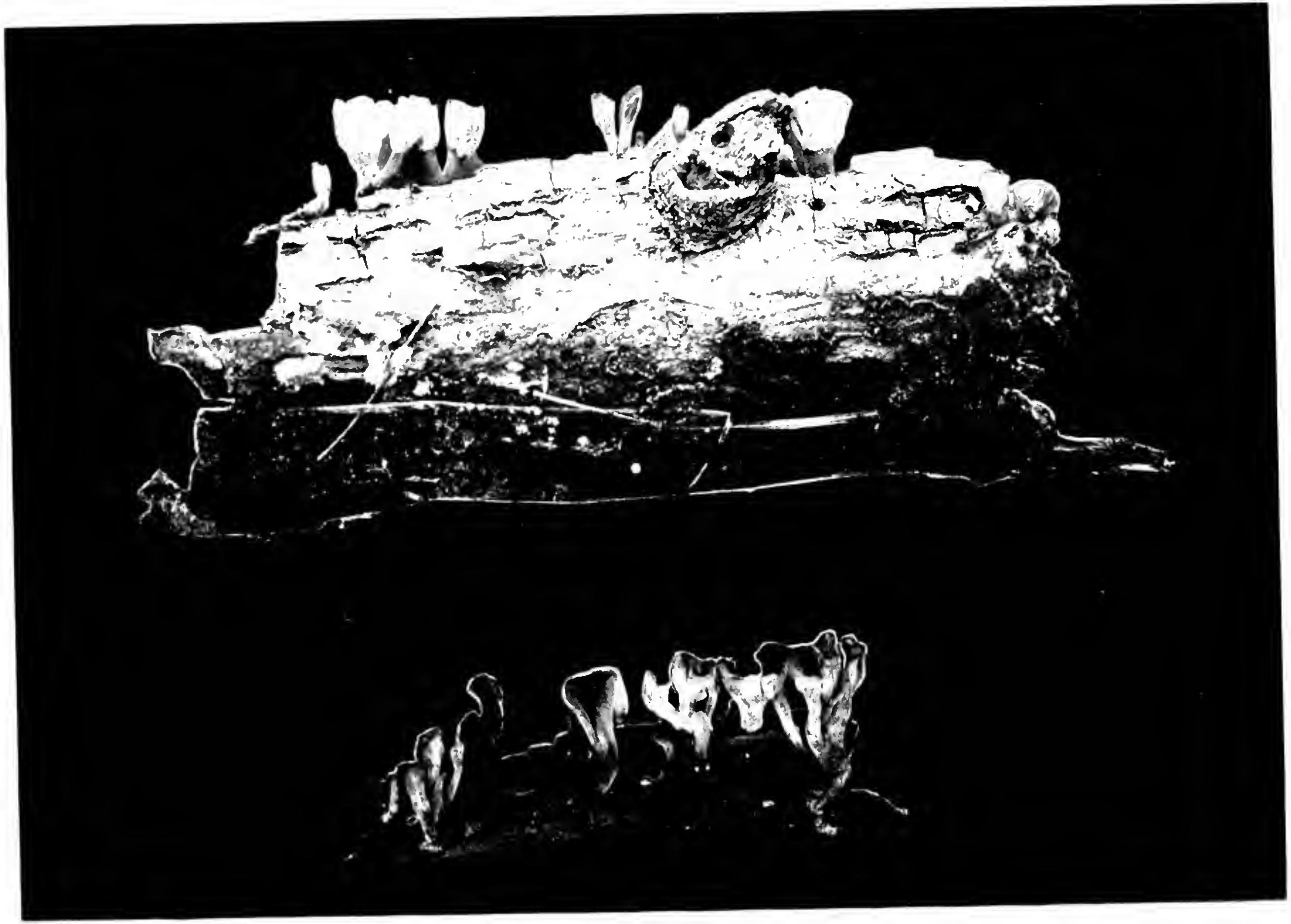
Growing on pine, bursting through bark, color orange yellow.......... *D. radicata* (1)
Growing on deciduous wood; about clay color; very small.......... *D. albizziae* (2)

1. **Ditiola radicata** (Alb. & Schw.) Fr.

PLATES 49, 50 AND 63

Plants gregarious or crowded into lines or masses up to 1.1 cm. long, 1-5 mm. high, abruptly expanded at top into a horizontally flattened, irregular, dull, orange-yellow head, bearing the hymenium,

PLATE 51



GUEPINIA SPATHULARIA. No. 3377

which is about 1.5-3 mm. broad, often depressed by a central wrinkle with the margin a little lobed or at times deeply constricted to form a compound head or two separate heads, or further compounded and crowded by branching of the stem below; the exposed stalk short, only up to 1 mm. long and 1-1.5 mm. thick, unless compounded, not visible plainly except in youth, usually flattened, descending through the bark by a flattened, whitish root about 2-3 mm. long, tough and hardly subgelatinous. Texture of cap firm and toughly gelatinous, softer on exposure in age.

Spores (of No. 4183) bent-elliptic, 4-celled before sprouting, 5-6.6 x 11-16.6μ; basidia slender, two-forked.

The head is distinctly viscid when wet, and when young is covered with an inconspicuous, subhyaline, outer coat which softens in water and seems to be washed off in particles. After disappearing from the top a remnant of it may be seen when soaked as a little area of fringe around the margin of the head. The stalk penetrates holes and cracks in the bark as a root and disappears into more or less obvious plates of mycelium. The root is often branched from the base or further up to form a compound row or group. It is usually glabrous on exposed part, and where protected by bark it is whitened and somewhat fibrous with mycelium. The smaller or younger plants have very little, if any, free stem above the bark. As parts of the bark are easily removed in handling, one might be misled as to what part of the stem-root was exposed. On drying the plant shrinks, but retains its form unless old and softened; the color of the cap becomes a translucent red, with the exposed stalk about the same color or more brown, while the rooting part remains whitish. Old plants exposed to rain lose much of their color and dry pale and membranous.

Our plant is most like *Dacrymyces aurantius*, but differs from it in the less ample and less plate-like root, viscid head, and shorter spores with only four cells. Large and mature plants cannot be distinguished with certainty from it without reference to the spore characters.

Lloyd has seen my plants, and I am following him in calling this *Ditiola radicata*, as he has collected that species in Sweden and should know it. There are discrepancies between our plants and the descriptions of this species. For example, Fries says it is covered with a flocculent white coat when young, and the spores are given by Hennings as two-celled, 3.8-4 x 8-10μ. Plants in the Curtis Herbarium

from Fries labelled *D. radicata* are not like my plants, but more like small specimens of my *Dacryopsis ceracea*. Spores, if present, are collapsed and shapeless. Plants in the same herbarium from Society Hill, S. C., on pine labelled *Ditiola gambosa* B. & C. looks just like our collections, but no spores could be found. It is also to be noted that collections from Europe in New York Botanical Garden Herbarium are on old, decorticated, weathered wood, and seem different from ours.

This agrees well with Massee's description of *Dacryopsis nuda* (Jour. Myc. **6**:182. 1891), and looks exactly like the figures of a plant collected by Beardslee at Asheville and referred by Lloyd to *D. nuda* (Myc. Notes **57**:841, figs. 1406-1408. 1919). According to Hennings's description also our plant agrees better with *D. nuda*. He gives spores of the latter as 4-celled, 5 x 14μ.

3968. On corticated pine wood, back of Athletic Field, January 17, 1920. Spores not septate when shed, 6.3-7.4 x 16.3-20μ.
4025. On decayed cedar limb, January 24, 1920. Spores curved-elliptic, some 4-celled, 6-7.4 x 12.9-16.6μ.
4109. On a fallen corticated pine branch, February 13, 1920. Photo.
4155. On corticated pine branch, February 21, 1920. Spores orange, curved-elliptic, 4-celled, 6-7.5 x 12.2-17μ.
4175. On corticated pine branch, February 21, 1920, Spores 5.5-6.5 x 11.3-18.5μ.
4180. On corticated pine limb, February 26, 1920. Spores 5.5-7 x 11-17μ, 4-celled.
4183. On corticated pine, February 25, 1920.
4192. On corticated pine limb. February 26, 1920.

2. **Ditiola albizziae** n. sp.

PLATE 64

Very small, centrally attached by a point, scarcely stalked, spreading out like a Peziza with the top flat, pale dull yellow (about clay color), hardly 1.5 mm. broad at top and less than 1 mm. high. Texture of cup waxy, toughish, the hymenium gelatinous; not reviving well when moistened.

Spores elliptic, two-celled, 4.5 x 8.5-9.5μ. Basidia slender, two-forked. See drawing.

This cannot be *D. sulcata* Schw., as a specimen from his herbarium (New England, Torrey) now in Curtis Herbarium has long, allantoid spores, 7.5 x 34μ long.

3996. On a dead branch of *Albizzia Julibrissin* (Mimosa) in Arboretum, January 21, 1920. Type.

CALOCERA

Plants growing on wood, upright, more or less terete throughout, simple or often branched, small, rarely up to 6 cm. high, often in rows from cracks; firm, tough, pliable, viscid, subgelatinous when very wet, orange or yellow, the hymenium covering all the plant except the whitish base (amphigenous). Basidia terete, elongated, forked into two long prongs each of which bears a spore; spores smooth, yellowish, sausage-shaped, divided into two cells before sprouting.

The hymenium is much denser than the inner flesh and is composed of densely fascicled groups of horizontal basidia which do not mature simultaneously. The plants resemble the Clavarias in form and are separated from them by their tough and more gelatinous structure, viscid surface and long-forked basidia.

KEY TO THE SPECIES

Growing on pine, gold or orange color, up to 6 cm. high..*C. viscosa* (1)
Growing on pine, yellow, minute, only up to 2 mm. high..*C. cornea* var. *minima* (3)
Growing on deciduous woods..*C. cornea* (2)

1. **Calocera viscosa** (Pers.) Fr.

This plant has the form of a Clavaria, about 2-6 cm. high, slender, stalked, several times branched, the tips acute; color deep golden yellow or orange yellow, orange when dry, surface very viscid; texture tough and pliable, the base extending into a slender whitish root.

Spores oblong, curved, smooth, probably light yellow, about 4.5 x 9-11μ, divided into two cells before sprouting.

Not rare on pine stumps and usually in rows from cracks. We have seen it at Chapel Hill, but failed to make notes. The above description is therefore compiled from others. Distinguished from *C. cornea* by growth on pine, larger size and deeper color.

For good illustrations in color see Gillet, Pl. 85 (118), fig. 1; and Massee: British Fungi and Lichens. Pl. 27, fig. 8.

2. **Calocera cornea** (Batsch.) Fr.

PLATE 65

Cespitose and often fused at base, forming clumps or extended rows from cracks in the bark, about 5-15 mm. high, cylindrical, pointed at the tips, simple or a few times branched or pronged like an antler

above: viscid: color ochraceous yellow, or when very wet and swollen a paler soaked yellow; texture tough, subgelatinous when very wet.

Spores (of No. 3834) creamy yellow, smooth, bent, 3.8-4.8 x 9.3-11.1μ.

The plants are horny and reddish when dry or blackish when old. The base is subtomentose from the mycelium. The color of the fresh plants is removable by soaking in water overnight. The water becomes yellow and the plants when taken out dry whitish. With us the species is not rare on deciduous wood. See Gillet, Pl. 85 (118), fig. 2. *Calocera palmata* is probably the same. See Myc. Notes **62**: figs. 1656 and 1657 (as *C. palmata*) and fig. 1658 (as *C. cornea*). 1920.

A very delicate plant on pines and cedar that we find here may be a different species, but the spores and basidia are the same as in the above. Lloyd thinks it only a form. As extensive colonies run all about the same size and never cespitose, I have decided to treat it as a variety of *C. cornea*, as below.

3824. On fallen branches of Liriodendron, December 5, 1919. Spores creamy-yellow, smooth, mostly bent-elliptic, 3.7-4.8 x 7.4-10μ.

3834. On rotting oak limb, woods east of cemetery, December 7, 1919.

3. **Calocera cornea** var. **minima** n. var.

PLATE 65

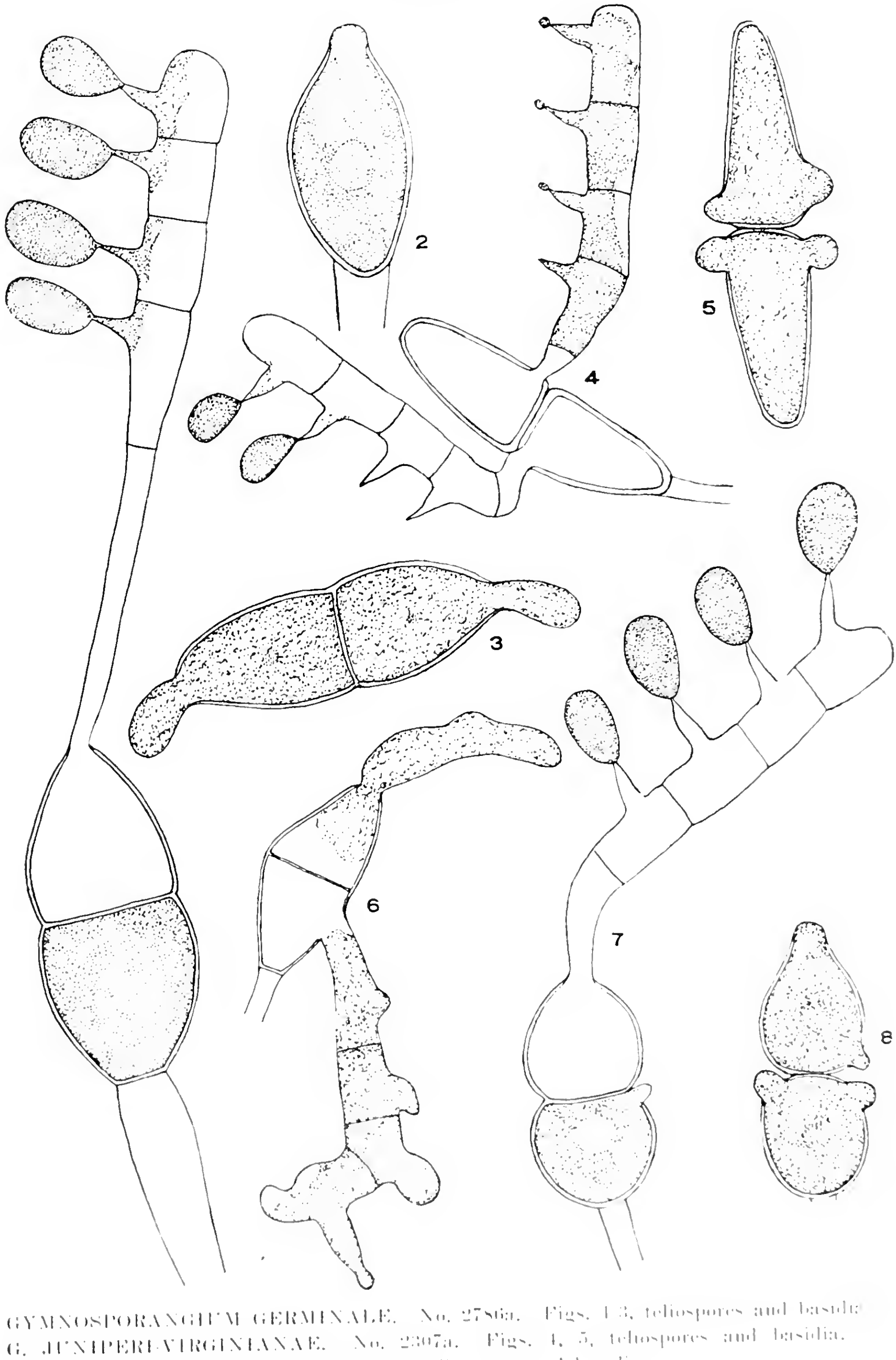
Minute, 1.5-2 mm. high, slender, densely gregarious, but not cespitose, simple or a few forked near apex or at any point, very rarely one branched into several prongs; stalk pale yellow or whitish, flatly and broadly attached, round, smooth, several times longer than the yellow, slightly enlarged, pointed, hymenium-bearing apex which looks not unlike that of *Mutinus caninus* in shape. This head may be a little rough or even knobbed or forked. Texture tough, subcartilaginous; surface viscid. Base pentrating the wood by a distinct root.

Spores (of No. 4088) elliptic, a little bent, yellowish under the microscope, two-celled a few days after falling, 3.8-5.5 x 7.4-11μ. Basidia forked, about 3μ thick.

4088. On a decorticated pine branch, February 4, 1920. Drawings.

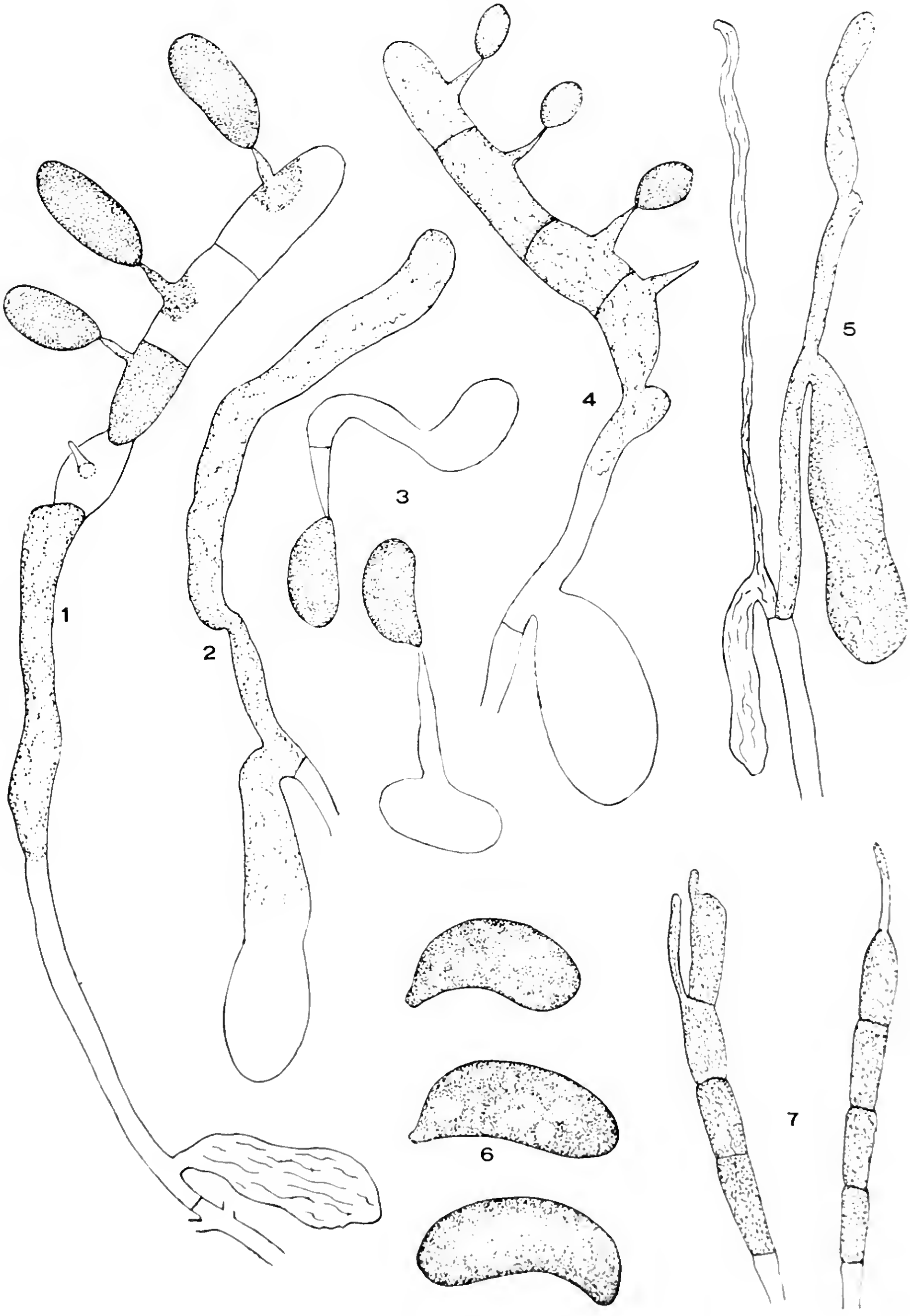
CHAPEL HILL, N. C.

PLATE 52



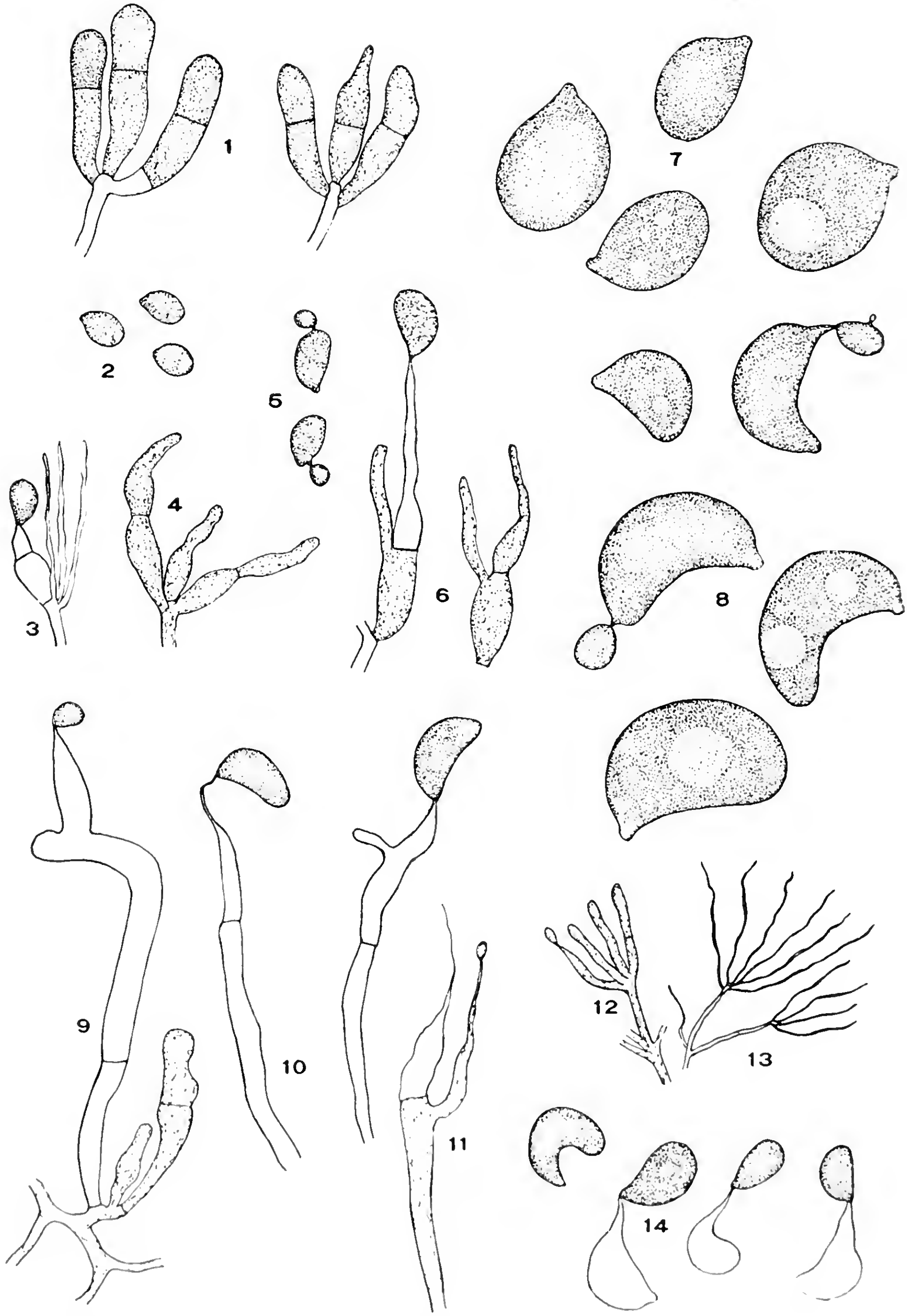
GYMNOSPORANGIUM GERMINALE. No. 2786a. Figs. 1-3, teliospores and basidia.
G. JUNIPERI-VIRGINIANAE. No. 2307a. Figs. 4, 5, teliospores and basidia.
G. NIDUS-AVIS. No. 2772a. Figs. 6-8, teliospores and basidia.
All x 715.

PLATE 53



SACCOBLASTIA OVISPORA VAR. CAROLINIANA. No. 4078. Figs. 1, 2, 4, 5, basidia showing spores and sacs; fig. 3, sprouting spores.
AURICULARIA AURICULA-JUDAE. No. 3835. Fig. 6, spores; fig. 7, basidia. Fig. 6 x 2160, others x 1080

PLATE 54

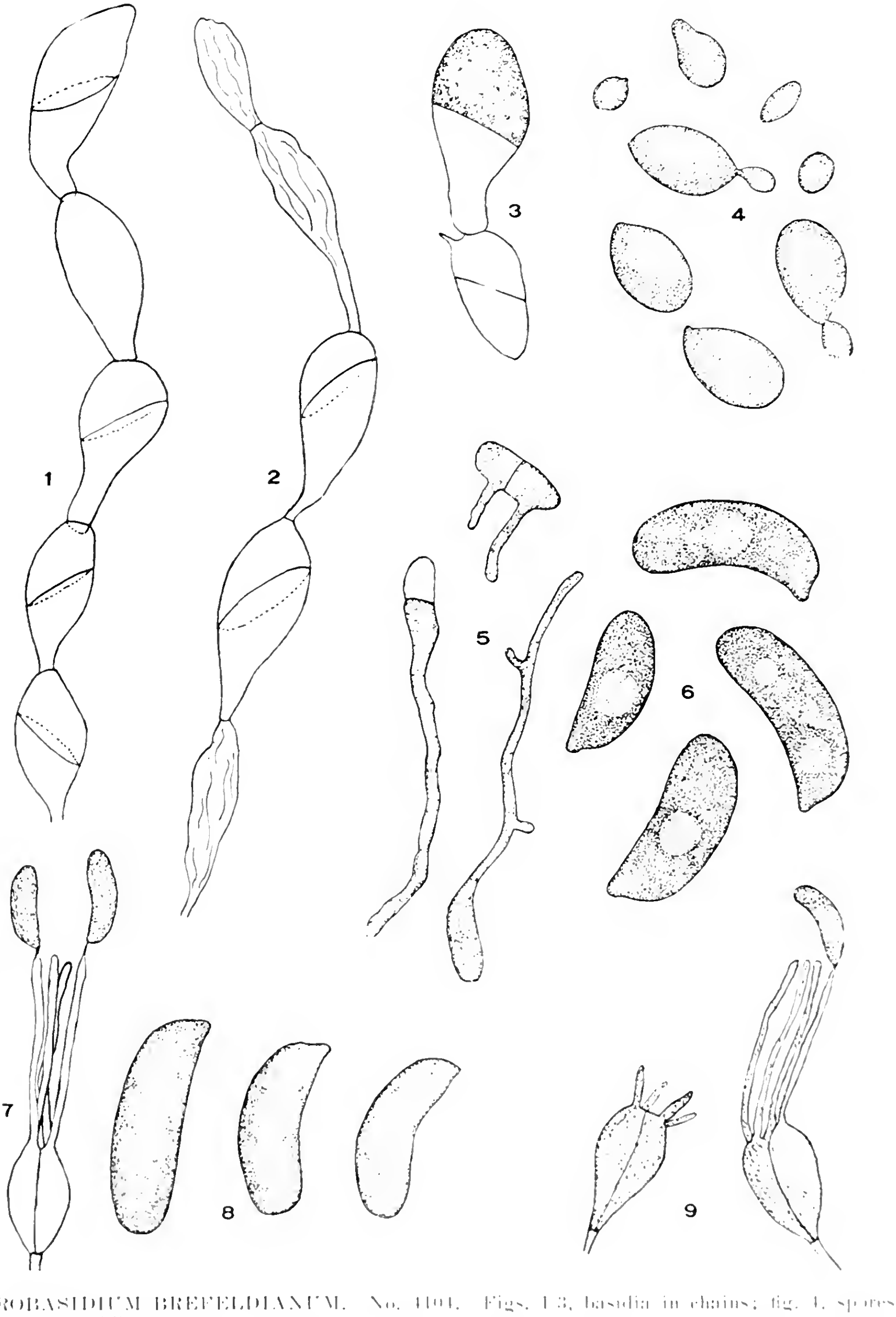


PLATYGLOEA CAROLINIANA. No. 4014. Figs. 1, 3, 4, 6, basidia; fig. 2, sporidia; fig. 5, sprouting spores; fig. 7, spores.

PLATYGLOEA LAGERSTROEMIAE. No. 4062. Fig. 8, spores; figs. 9-12, basidia; fig. 13, threads among basidia; fig. 14, sprouting spores.

Figs. 7, 8 × 2160, others × 1080.

PLATE 55



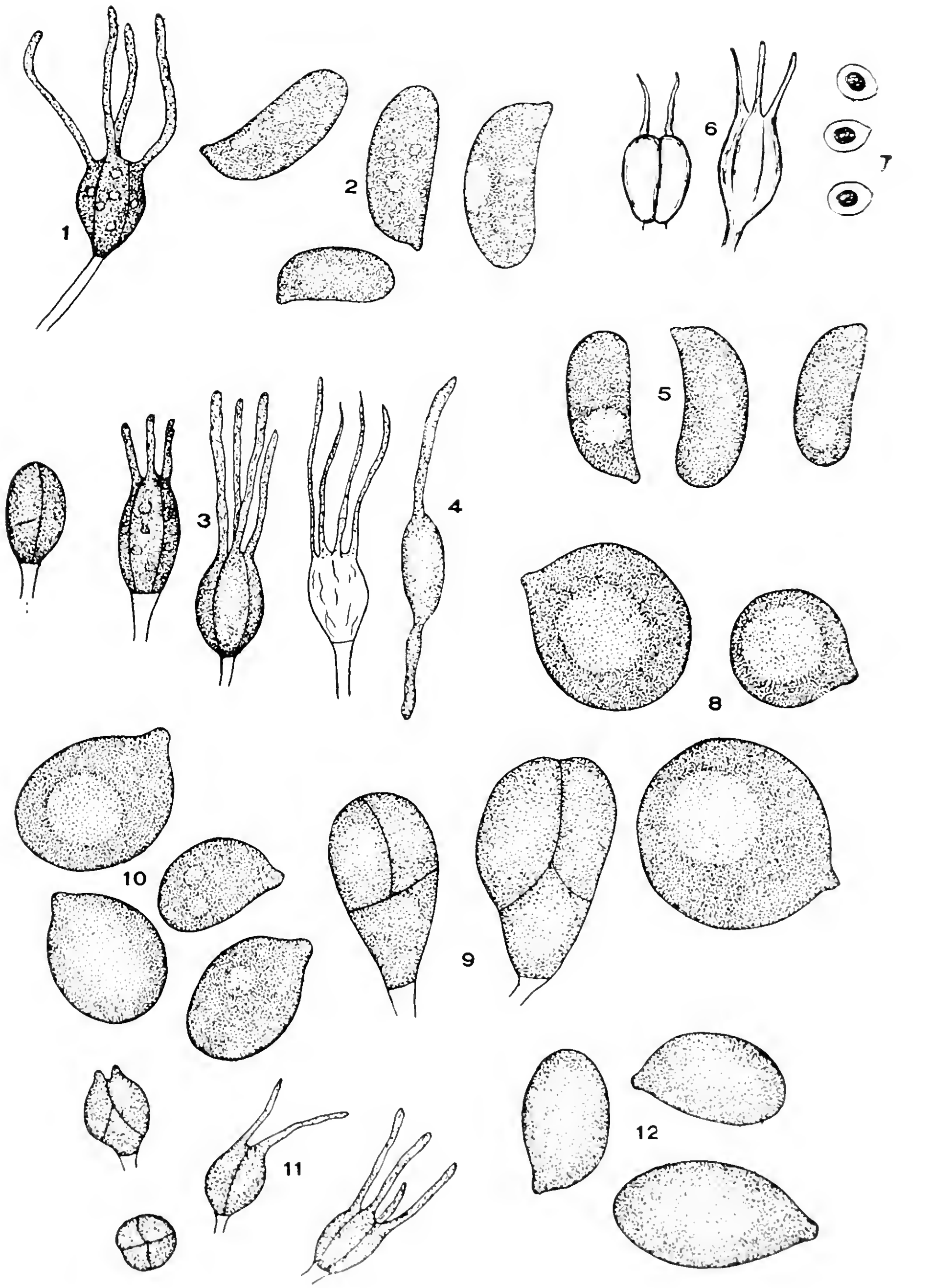
SIROBASIDIUM BREFELDIANUM. No. 4101. Figs. 1-3, basidia in chains; fig. 4, spores and sporidia.

EXIDIA GLANDULOSA. No. 3878. Fig. 5, sprouting spores; fig. 6, spores; fig. 9, basidia.

EXIDIA GELATINOSA. No. 3854. Fig. 7, basidium; fig. 8, spores.

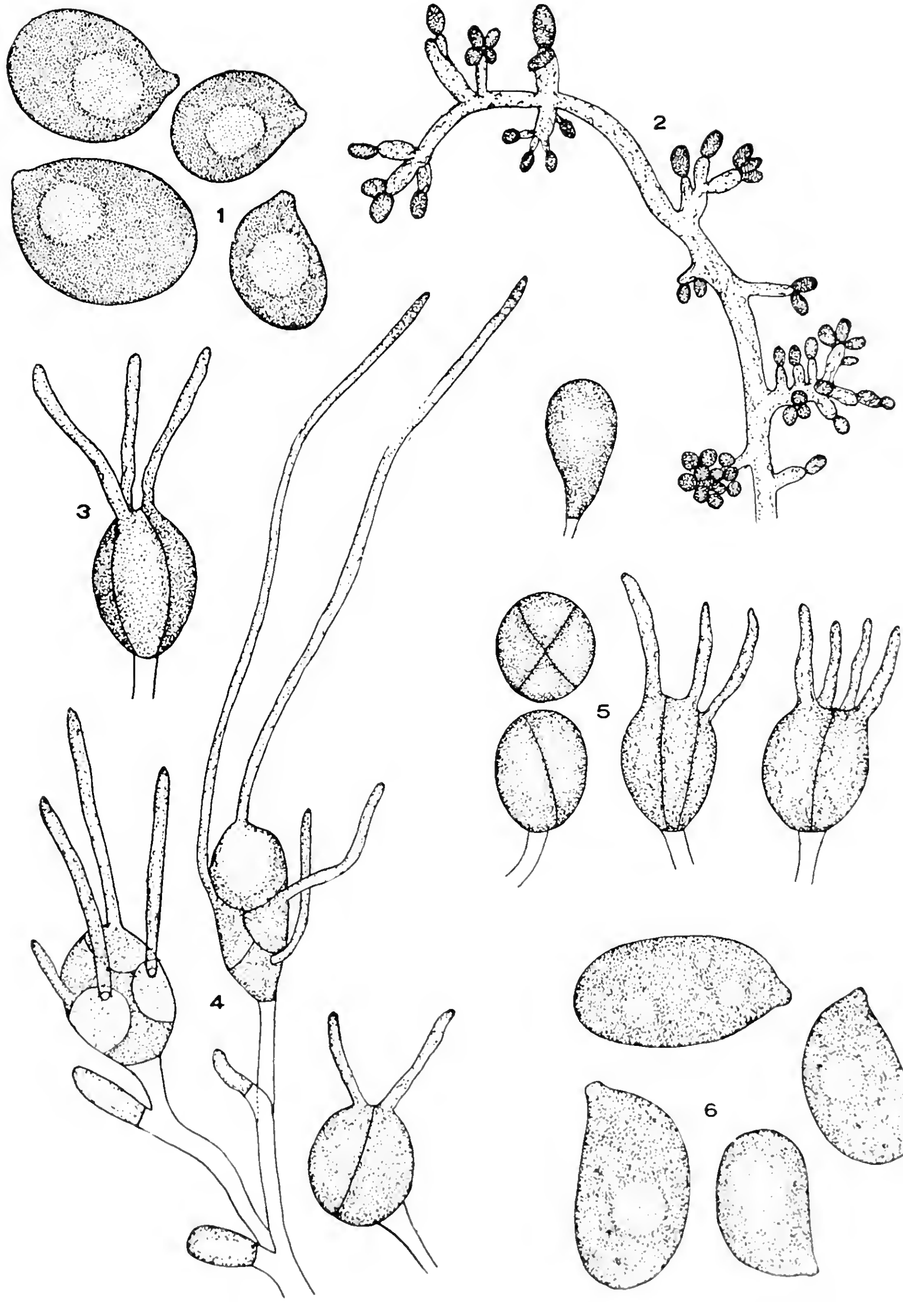
Figs 6 and 8 x 2160, others x 1080.

PLATE 56



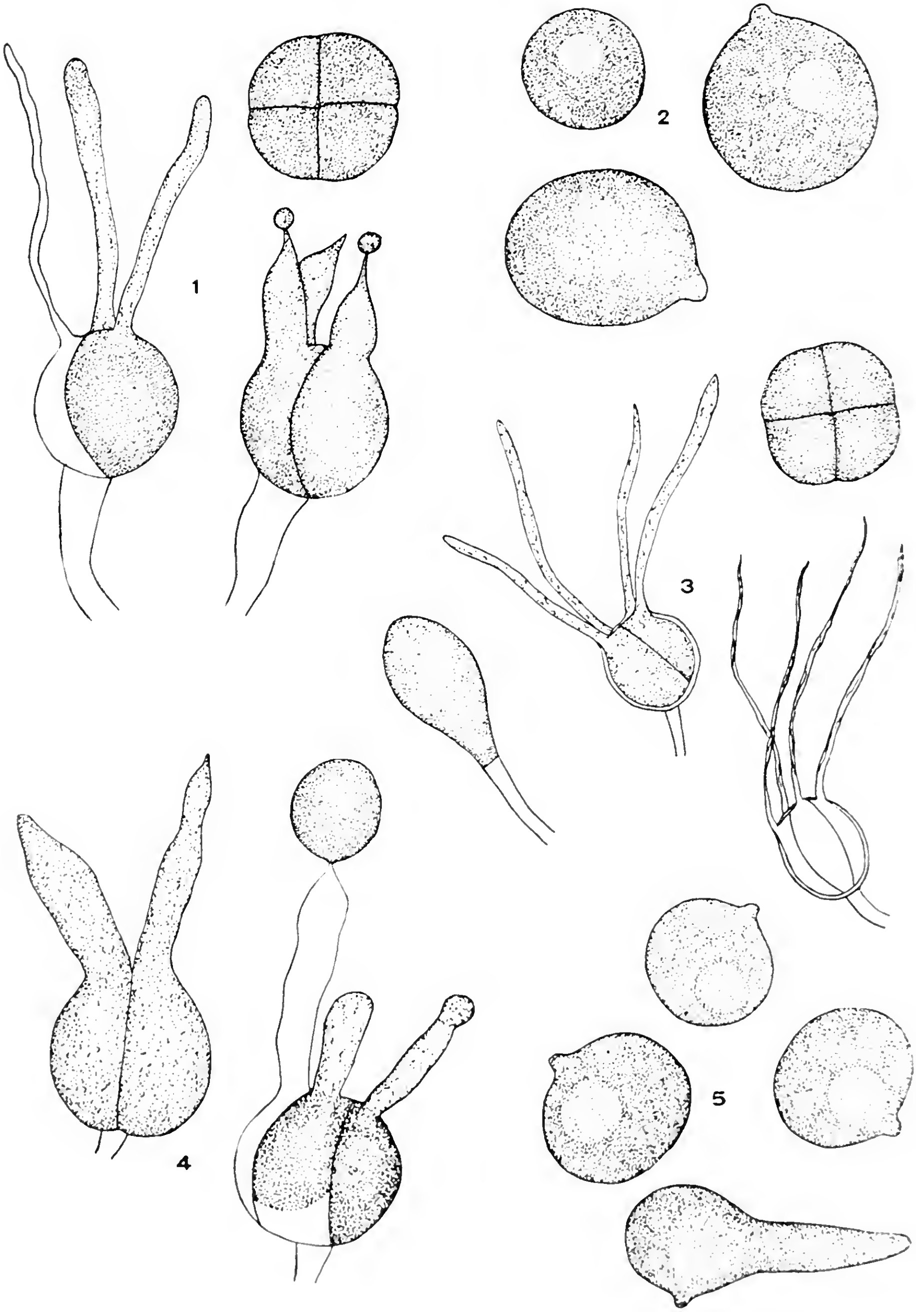
EXIDIA BEARDSLEEI. No. 3930. Fig. 1, basidium; fig. 2, spores.
NAEMATELIA NUCLEATA. No. 3956. Fig. 3, basidia; fig. 4, sprouting spore. No. 3959. Fig. 5, spores.
TREMELLA FUCIFORMIS. No. 1408. Fig. 6, basidia; fig. 7, spores
TREMELLA ASPERA. No. 3950. Fig. 8, spores; fig. 9, basidia.
TREMELLA FRONDOSA. No. 1173. Fig. 10, spores; No. 2456. Fig. 11, basidia
TREMELLA RETICULATA. No. 2690. Fig. 12, spores.
Figs. 2, 5, 8, 10, 12 × 2160, others × 1080.

PLATE 57



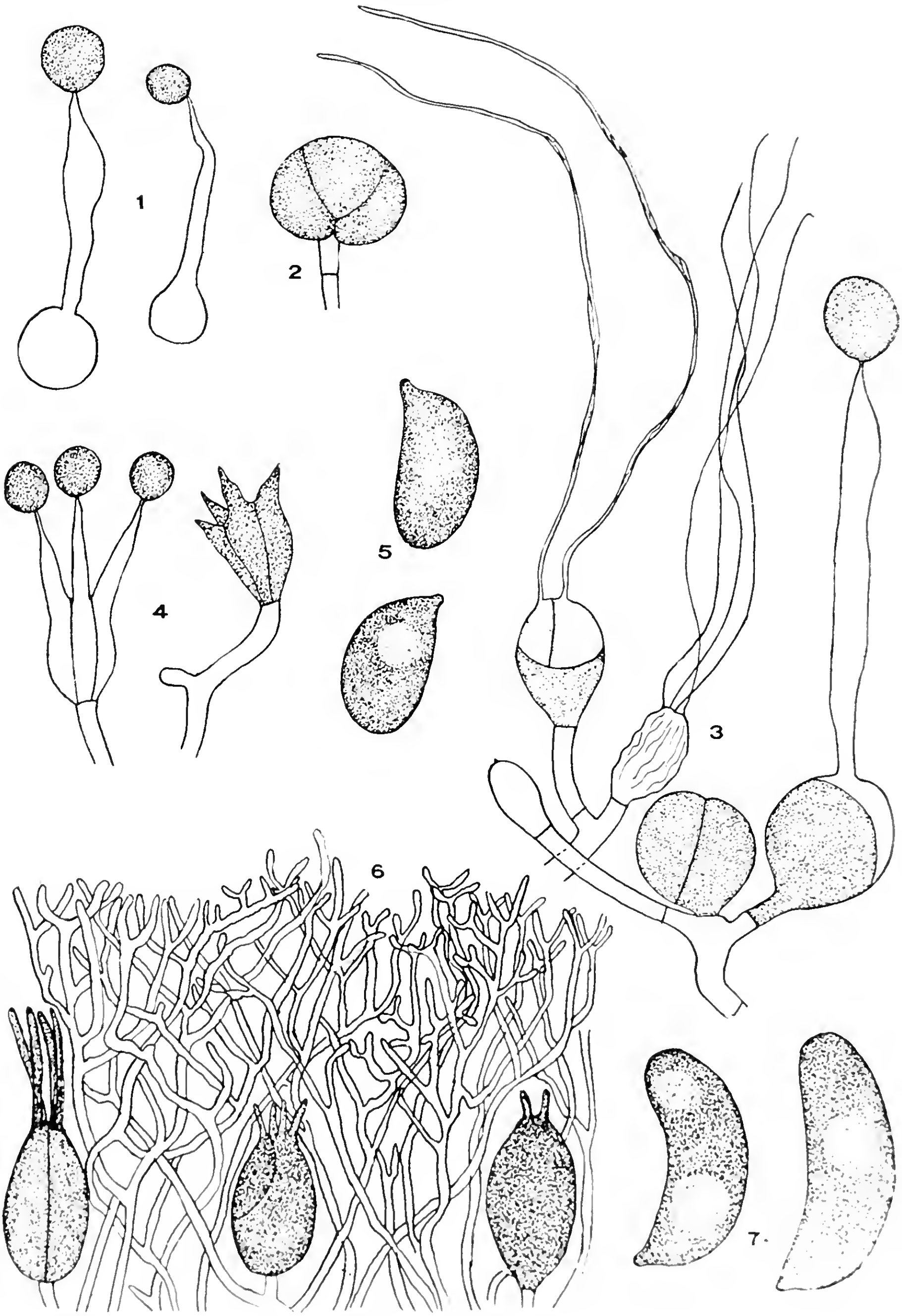
TREMELLA LUTESCENS. No. 3895. Fig. 1, spores; fig. 2, conidiophore (of No. 4069); fig. 4, basidia. No. 3916. Fig. 3, basidium.
TREMELLA VIRENS. No. 3070. Fig. 5, basidia; fig. 6, spores.
Figs. 1 and 6 x 2160, others x 1080.

PLATE 58



NAEMATELIA QUERCINA. No. 3935. Fig. 1, basidia; fig. 2, spores.
TREMELLA SUBANOMALA. No. 4005. Fig. 3, basidia; fig. 5, spores.
TREMELLA PINICOLA. No. 4050. Fig. 4, basidia.
Figs. 2, 5 × 2160, others × 1080.

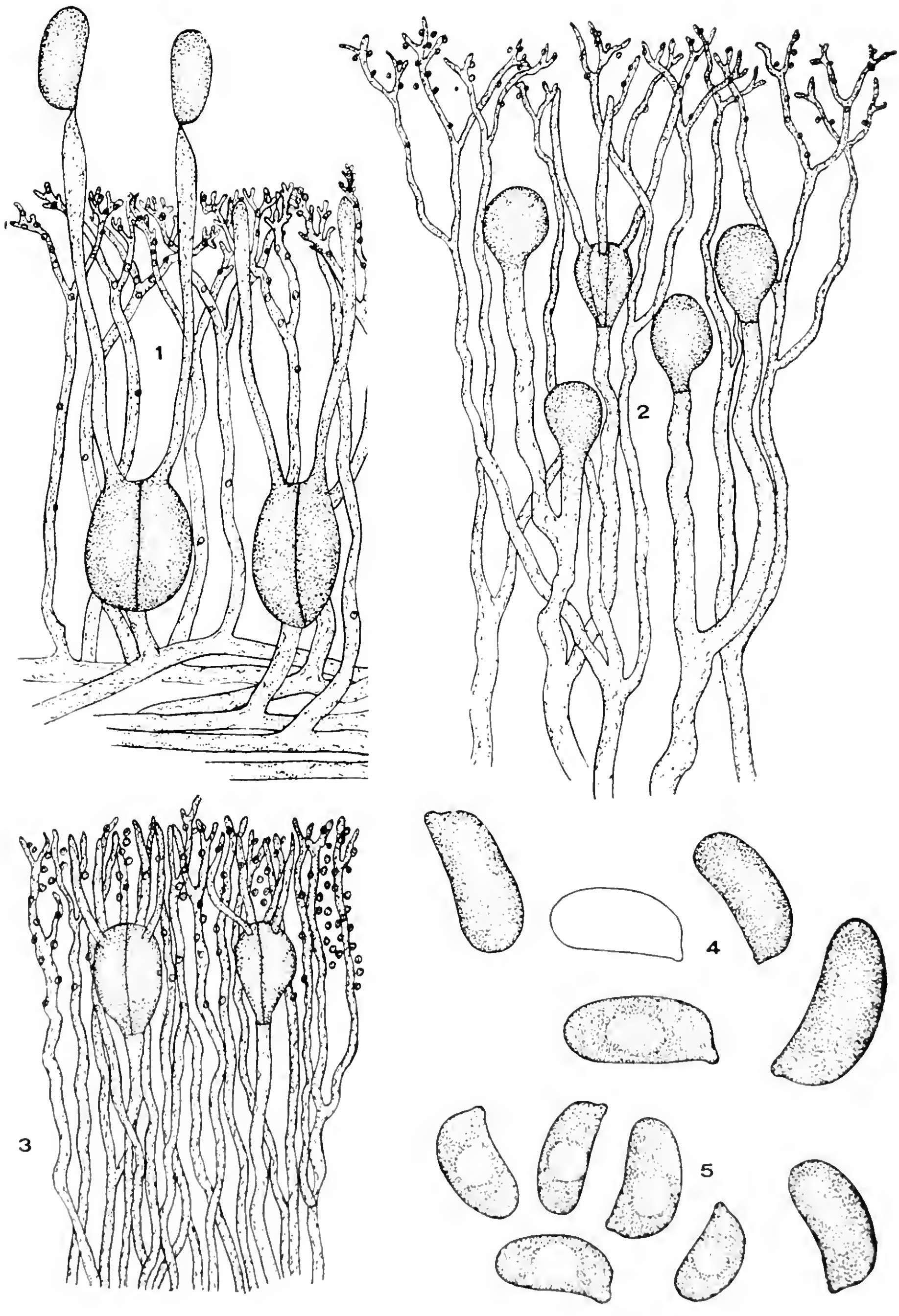
PLATE 59



TREMELLA CARNEOALBA. No. 3877. Fig. 1, sprouting spores; figs. 2, 3, basidia.
TREMELLODON GELATINOSUM. No. 912. Fig. 4, basidia and spores.
TREMELLODENDRON CANDIDUM. No. 1385. Fig. 5, spores.
EICHLERIELLA LEVEILLIANA. No. 3829. Fig. 6, section of hymenial surface, fig. 7, spores.

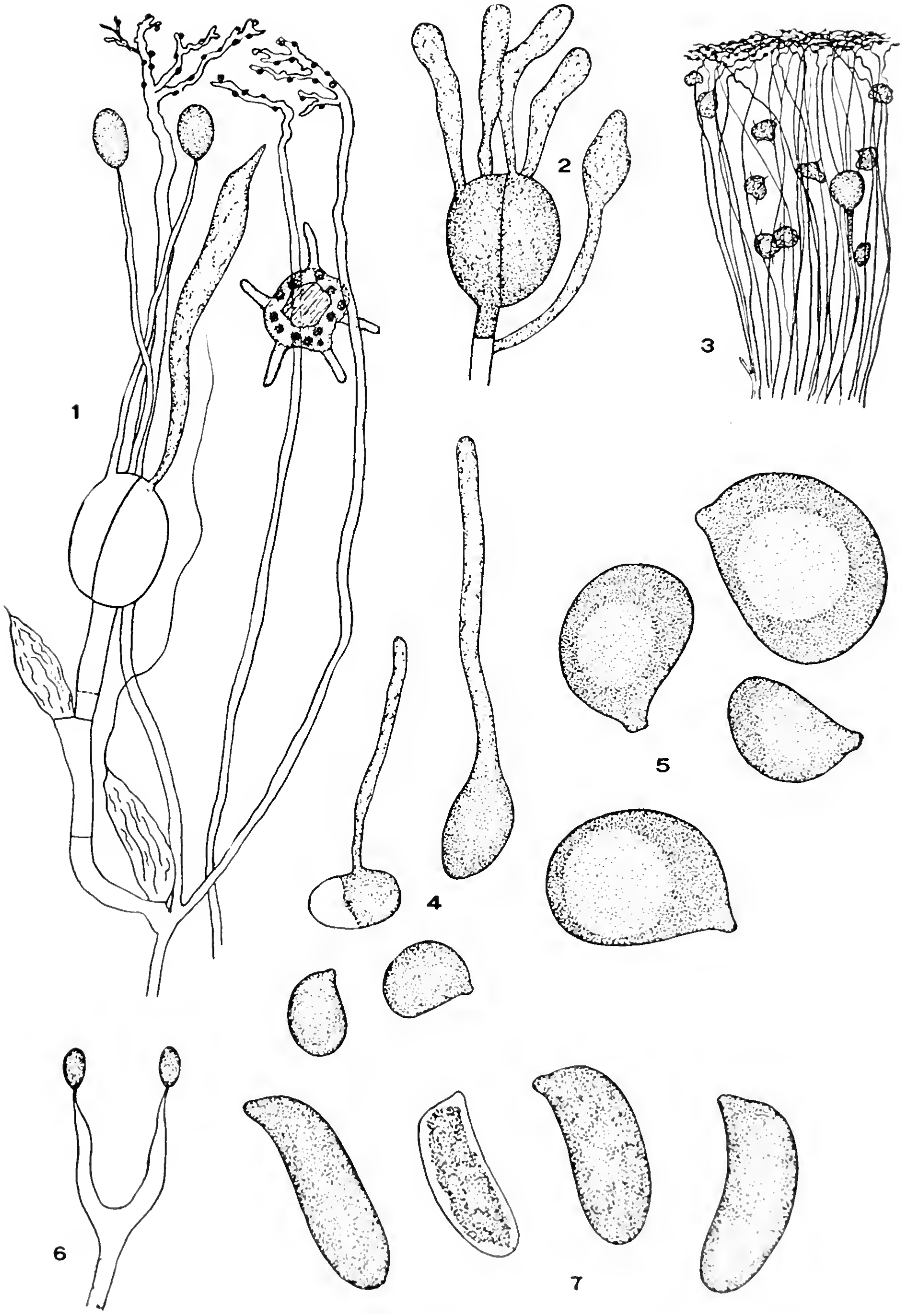
Figs. 5-7 × 2160, others × 1080.

PLATE 60



SEBACINA CALCEA. No. 3963. Fig. 1, section of hymenial surface.
SEBACINA SP. No. 4119. Fig. 2, section of hymenial surface; fig. 4, spores.
SEBACINA SP. No. 4118. Fig. 3, section of hymenial surface; fig. 5, spores.
Figs. 4, 5, x 2160, others x 1080.

PLATE 61

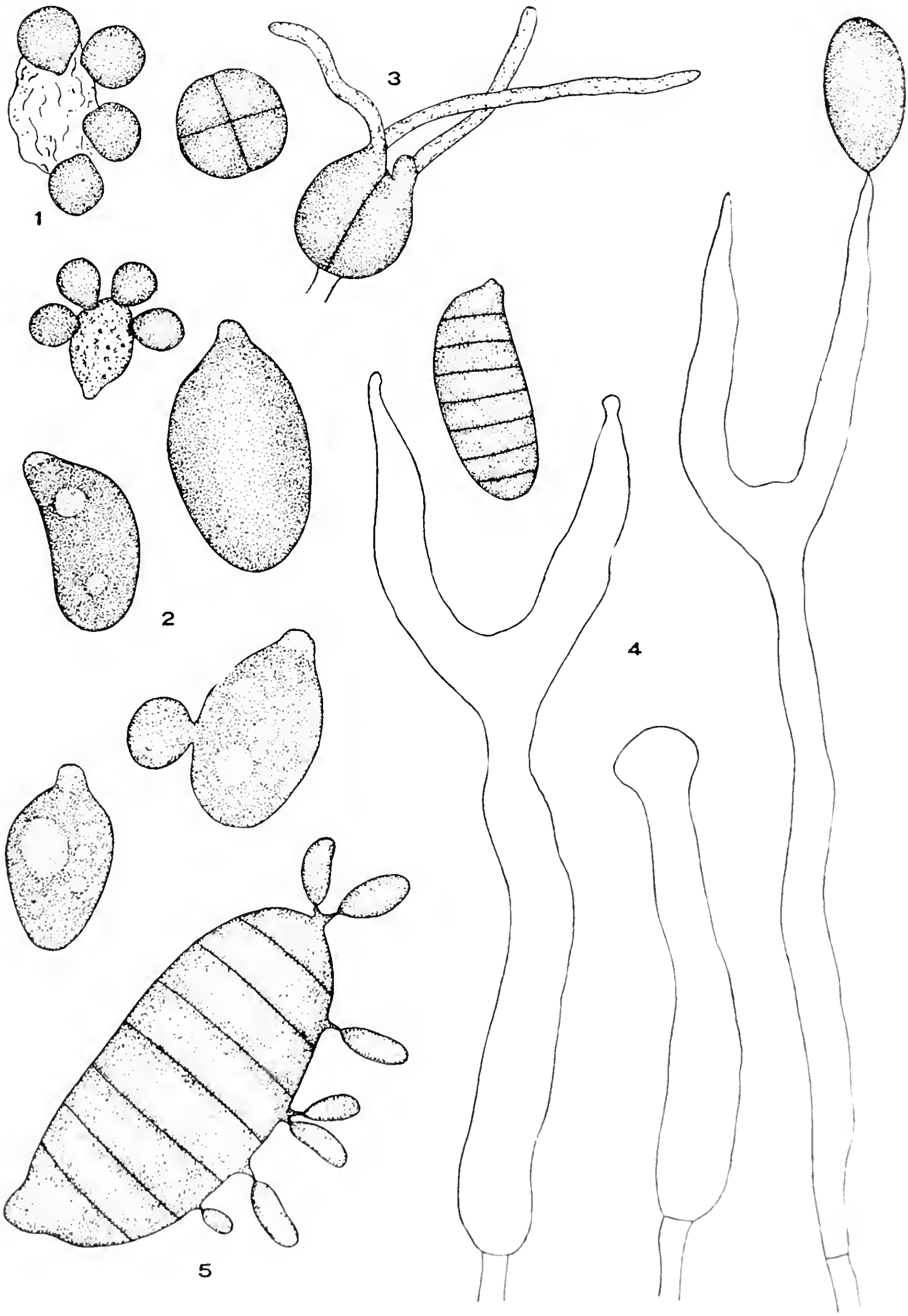


SEBACINA SP. No. 4116. Figs. 1, 2, basidia; fig. 3, section of hymenial surface, showing the large crystals; fig. 4, sprouting spores; fig. 5, spores.

DACRYMYCES PALLIDUS. No. 4072. Fig. 6, basidium; fig. 7, spores.

Fig. 3 x 370, figs. 5, 7 x 2160, others x 1080.

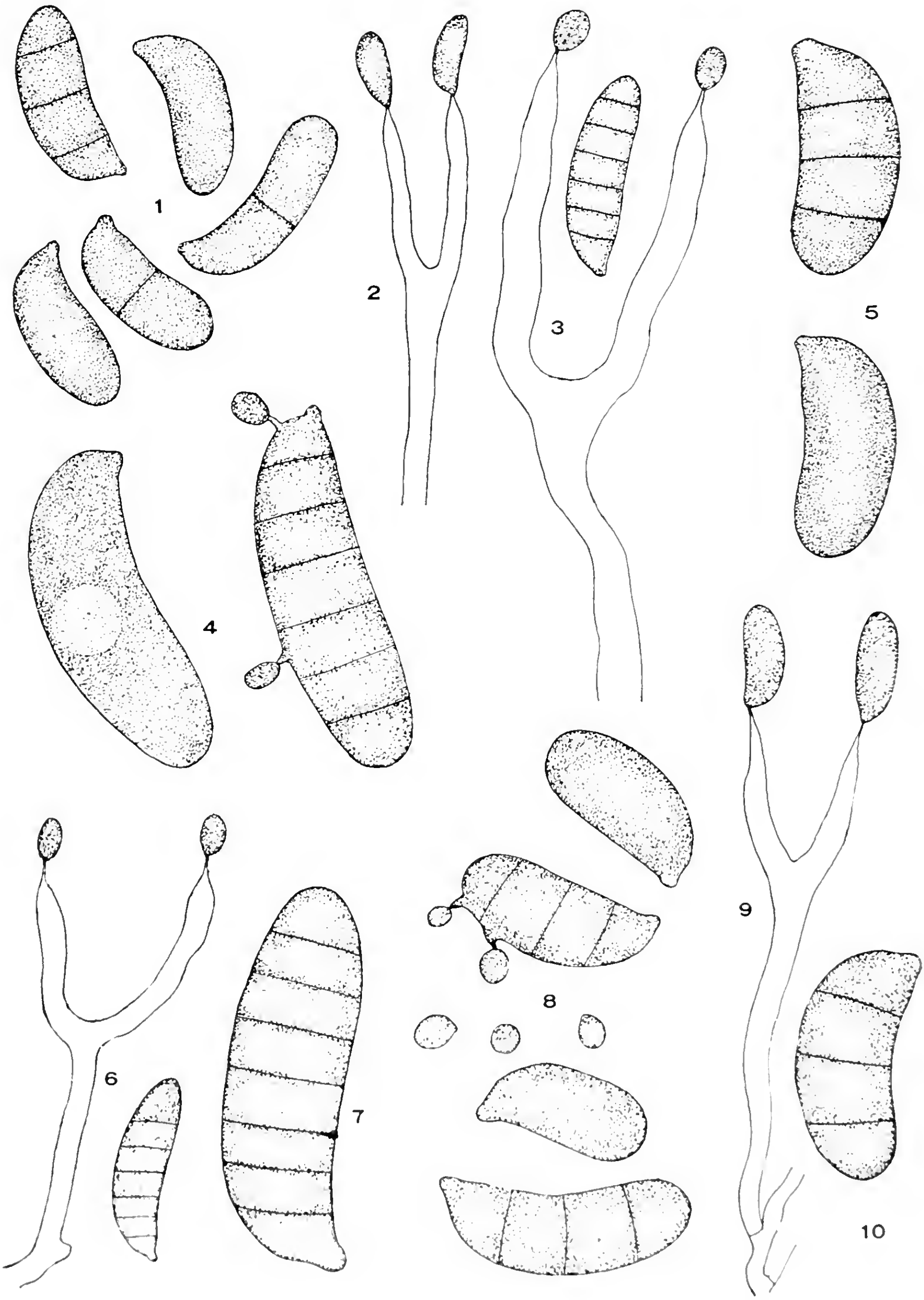
PLATE 62



TREMELLA AURICULARIA. No. 1159. Fig. 1, sporidia with remains of old spore; fig. 2, spores; fig. 3, basidia.

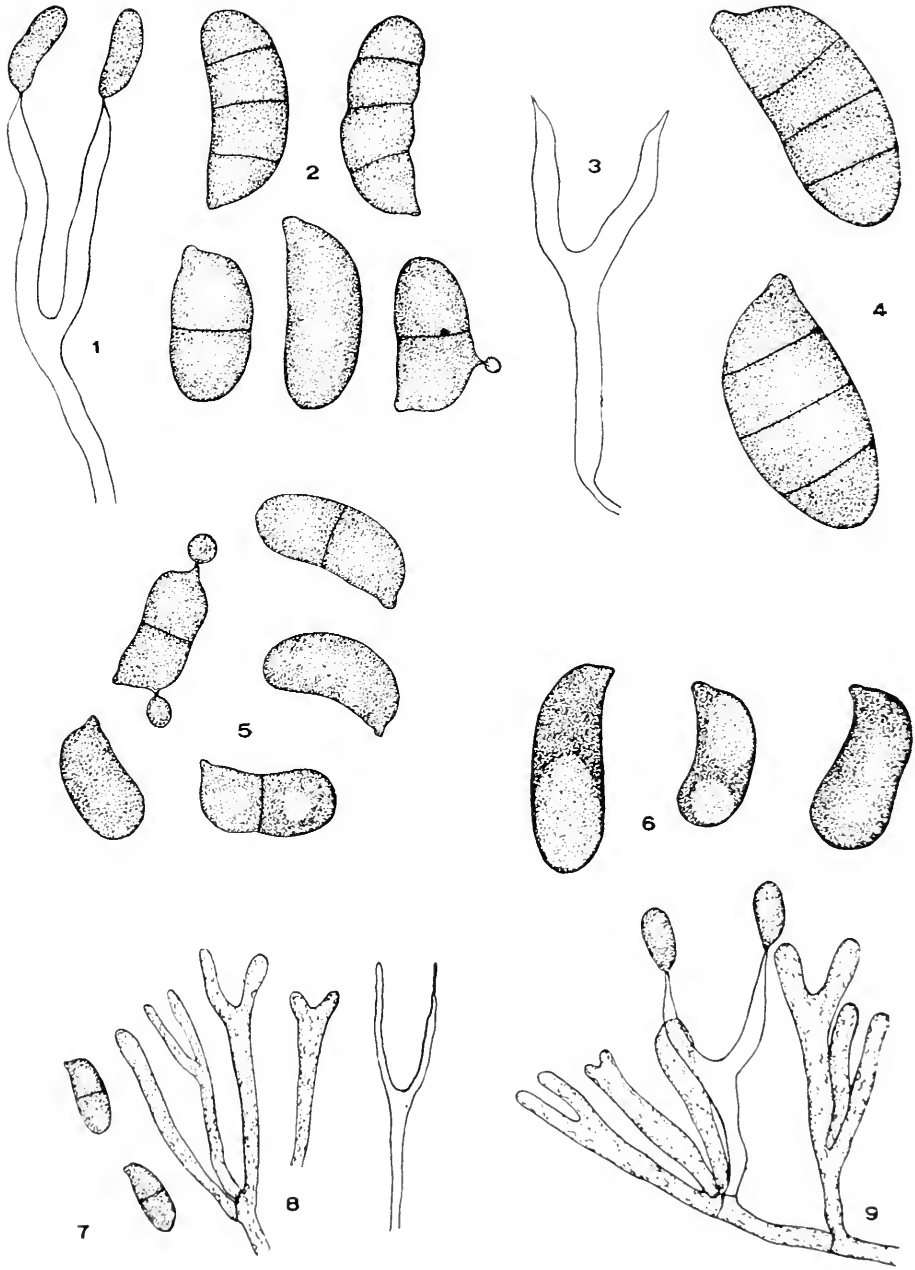
DACRYMYCES PEDUNCULATUS. No. 1158. Fig. 4, basidia; fig. 5, spores bearing sporidia. Figs. 1, 2, 5 x 2160, others x 1080.

PLATE 63



DACRYMYCES FUSCOMINUS N. SP. No. 4075. Fig. 1, spores; fig. 2, basidium.
DACRYMYCES ABIETINUS. No. 3832. Fig. 3, basidium; fig. 4, spores.
DACRYMYCES AURANTIUS. No. 3500. Fig. 6, basidium and spore; fig. 7, spore.
DACRYMYCES ELLISII. No. 3861. Fig. 8, spores and sporidia.
DACRYMYCES INVOLUTUS. No. 3972. Fig. 9, basidium; No. 4179. Fig. 10, spore.
DITIOLA RADICATA. No. 4183. Fig. 5, spores.
Figs. 1, 4, 5, 7, 8, 10 x 2160, others x 2080.

PLATE 64



DACRYMYCES MINOR. No. 3926. Fig. 1, basidium; No. 4200. Fig. 2, spores

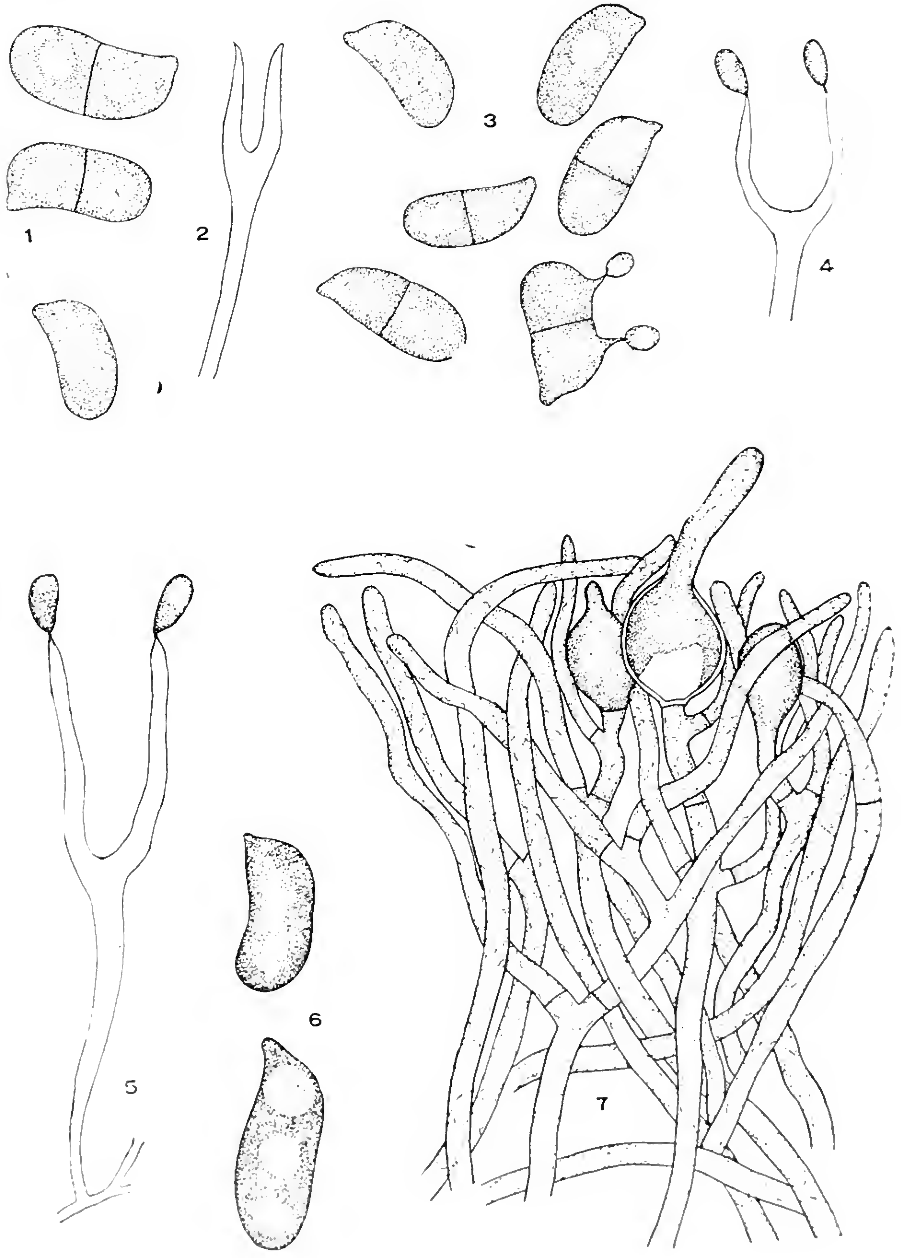
DACRYOMITRA DUBIA. No. 3969. Fig. 3, basidium; fig. 4, spores.

GUEPINIA SPATHULARIA. No. 3892. Fig. 5, spores; No. 3852. Fig. 6, spores; fig. 9, absidia.

DITIOLA ALBIZZIAE. No. 3996. Fig. 7, spores; fig. 8, basidia.

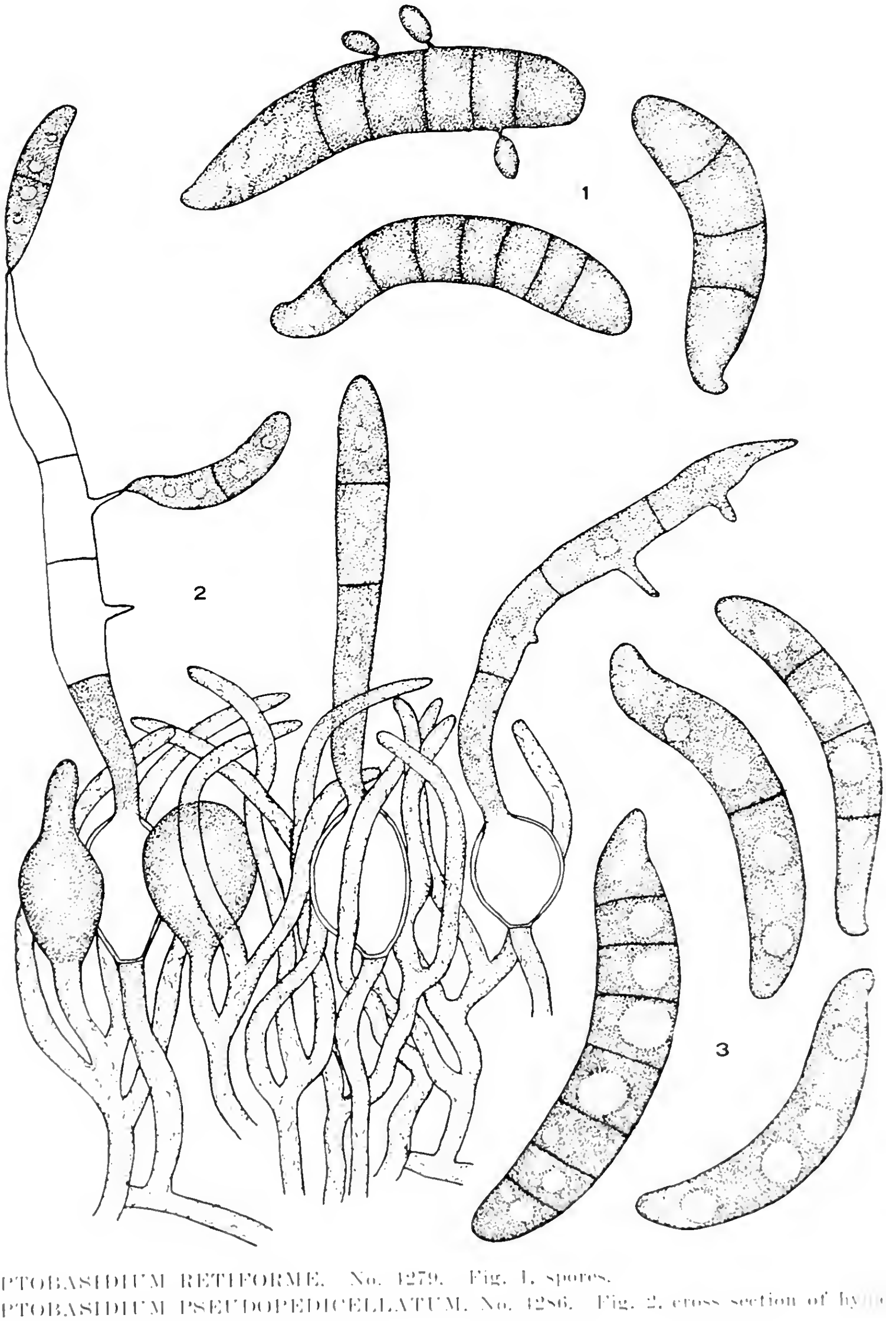
Figs. 2, 4, 5, 6 x 2160, others x 1080.

PLATE 65



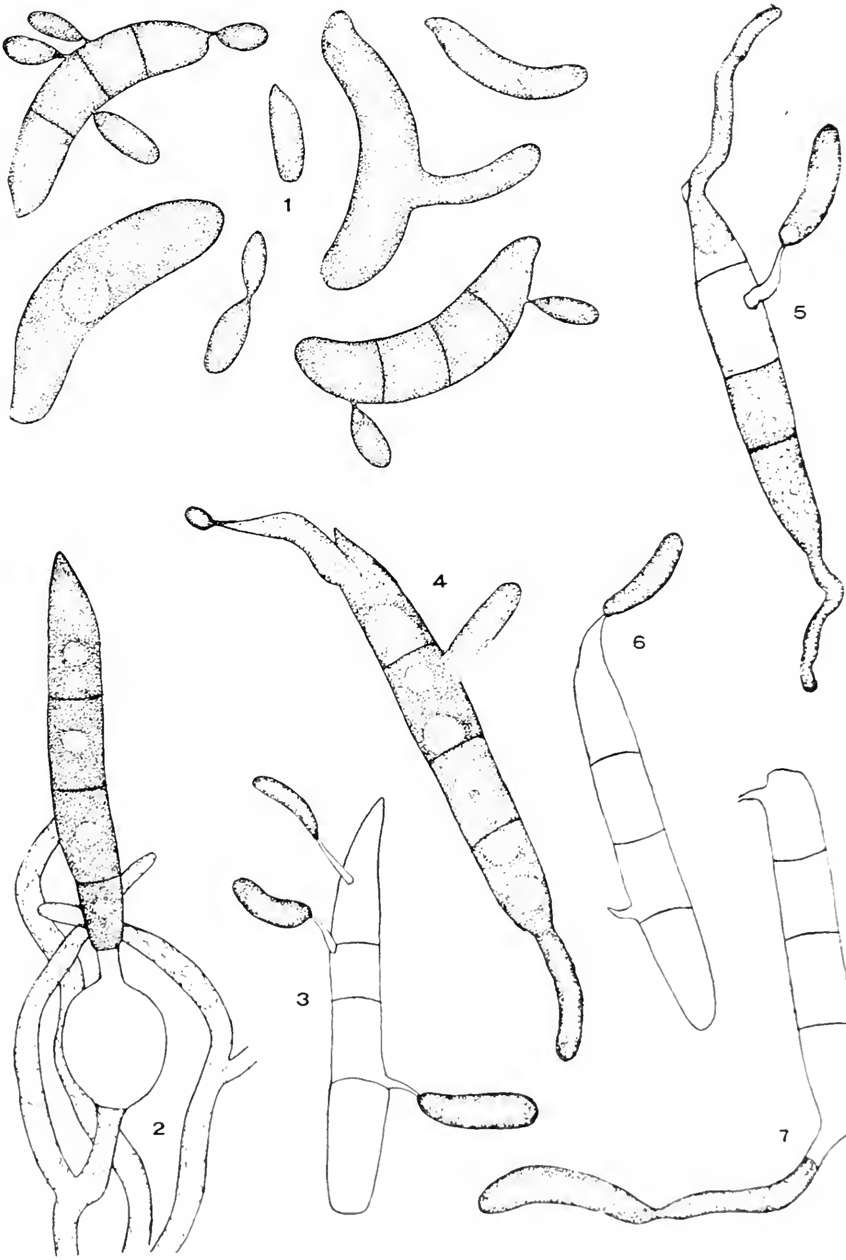
CALOCERA CORNEA var. MINIMA. No. 4088. Fig. 1, spores; fig. 2, basidium.
DACRYOPSIS CERACEA. No. 4121. Fig. 3, spores; fig. 4, basidium.
CALOCERA CORNEA. No. 3834. Fig. 5, basidium; fig. 6, spores.
SEPTOBASIDIUM RETIFORME. No. 4279. Fig. 7, cross section of hymenial surface
Figs. 1, 3, 6 x 2160, others x 2080.

PLATE 66



SEPTOBASIDIUM RETIFORME. No. 4279. Fig. 1, spores.
SEPTOBASIDIUM PSEUDOPEDICELLATUM. No. 4286. Fig. 2, cross section of hymenial surface; fig. 3, spores.
Figs. 1, 3, x 2160, fig. 2 x 1080.

PLATE 67



SEPTOBASIDIUM PSEUDOPEDICELLATUM. No. 4293. Fig. 1, spores and s[illegible].
SEPTOBASIDIUM RETIFORME. No. 4294. Fig. 2, section of surface showing orig[illegible] of basidia; figs. 3-7, basidia forming spores.
Fig. 1 x 2160, others x 1080.